HKEx Orion Market Data Platform (OMD)
Securities Market and Index

Technical Briefing

24 July 2012

AGENDA

Part 1	
Overview & On-boarding Activities	By Karen Lam Vendor Support & Data Management Market Data Department
Part 2	
Technical Features of OMD and Notes on Feed Handler Development	By Alan Tam Market Data Systems Information Technology Division
Part 3	
Network Matters	By Stephen Mak Network Operations & Engineering (SDNet) Information Technology Division
Part 4	
Q&A	All Speakers

AGENDA – Part 1

1. Overview of OMD Securities Market & Index
2. On-boarding Activities

Overview

Orion Market Data Platform (OMD)

HKEx Orion

HKEx Orion:

a transformative programme comprising new platforms and facilities designed to revolutionise HKEx's core trading platforms, including connectivity networks, a state-of-the-art data centre, and systems providing order matching, market data dissemination and market access services

Orion Market Data Platform (OMD)

OMD

an integrated low-latency platform delivering market data for all asset classes traded on HKEx markets in a common message format

- OMD Securities Market
- OMD Derivatives Market
- OMD Index

OMD Securities Market

OMD Securities Market comprises three (3) datafeed products:

- Securities Standard (SS)
- Securities Premium (SP)
- Securities FullTick (SF)

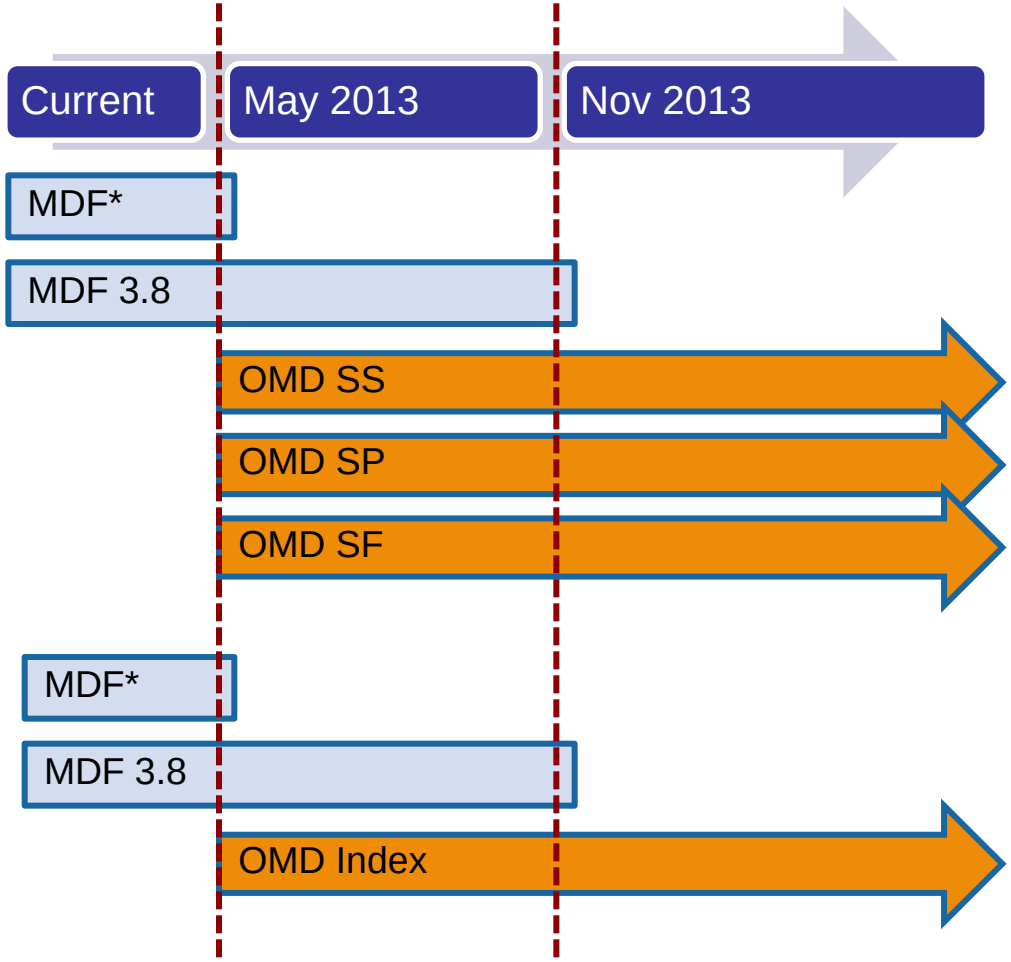
Overview
Product Rollout

Tentative Schedule

Securities Market Data		
Market by Price	Conflated	1000 sups 5 BBO
		2000 sups 10 BBO
	Streaming	10 BBO
Market by Order	Streaming	-

Index Data

sups – stock updates per second **BBO –** Best Bid & Offer prices



Overview

Product Profile

Contents	SS	SP	SF	Index
Reference Data	○	○	○	
Status Data	○	○	○	
Price Queue Update (10 BBO)	○	○		
Order Add / Modify / Delete			○	
Order Add / Delete (Odd Lot)	○	○	○	
Broker Queue	○	○		
Trade Tickers	○			
Trade / Trade Cancel		○	○	
Price and Statistics	○	○		
Indicative Equilibrium Price	○	○	○	
VWAP / Number of Trades		○		
News	○	○		
Index Data (HSI, S&P and CSIC)				○
Anticipated Bandwidth (Mbps)	10	60	20	1

○ Contents of feed ○ Complimentary Odd Lot Order Feed ○ Complimentary Conflated Broker Queue

Overview

Highlights of Differences (Technical)

Feature	MDS	OMD	Points to Note about OMD
Transmission Protocol (Real-time Data)	Unicast	Multicast	• Detection of data loss and data recovery • Race condition as a result of data transmission from multiple channels
Data Recovery	• From same connection • Database download	• Latest image – Refresh (multicast) • Gap filling – Retransmission (unicast)	• Different IP address to receive same data from Refresh channels • Retransmission is optional • Limited number of messages available in cache for retransmission

Overview

Highlights of Differences (Trade and Price Data)

Data	MDS	OMD	Points to Note about OMD
Price Queue Update (10 BBO)	Full Price Queue Information	Changes only, including new order prices and change of quantity	Client's system to create order book from the changes, e.g. shifting of queue positions and deleting price queues beyond the top 10 price levels, etc.
Trade Information	Trade Tickers	Individual Trades (SP, SF)	Trade Information in SS at same level as MDS
Trade Time	Up to Minute	Up to Second	
Odd Lot Order	Price Queue Only	Full Odd Lot Order Book	Broker ID provided to facilitate odd lot trading

Overview

Highlights of Differences (Value Added Data)

Data	MDS	OMD	Points to Note about OMD
Exchange Rate	Not Provided	Provided	Same exchange rate for calculation of market statistics
Market Turnover	HKD and RMB Only	• Separate figures for individual currencies • Total market turnover in HKD	
VWAP	Not Provided	Provided (SP only)	
Number of Deals	Not Provided	Provided (SP only)	
Spread Table	Provided	Not Provided	Refer to Schedule 2 of Rules of the Exchange available on HKEx website
Linked Securities	Provided	Not Provided	Derive from the Underlying Code of various securities if list of derivatives of a single stock is needed
Trading Timetable	Provided	Not Provided	Refer to HKEx website

AGENDA – Part 1

1 Overview

2 **On-boarding Activities**

On Boarding Activities

First Batch Schedule

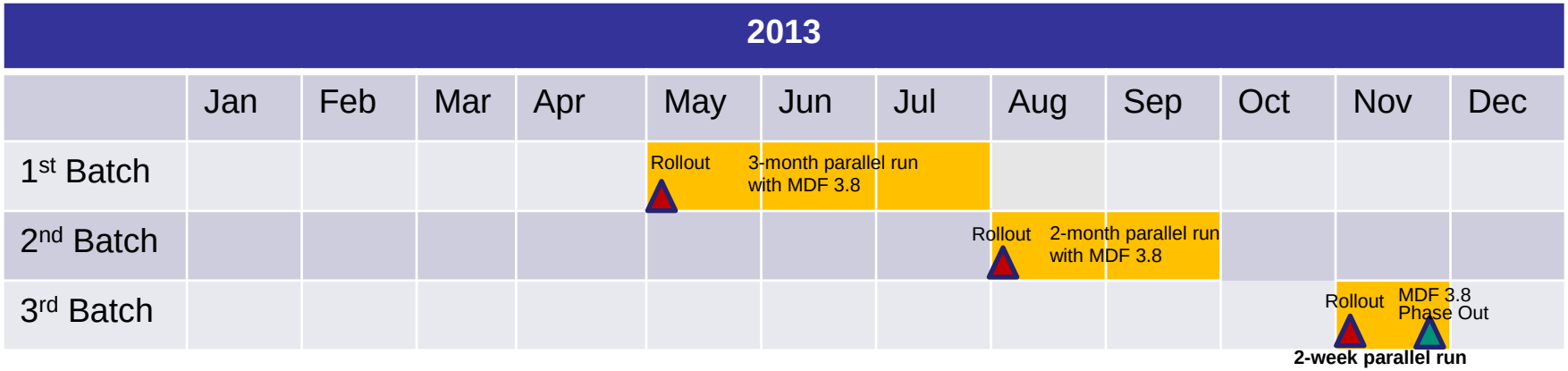
Tentative Schedule

Jul-Aug 2012	Jul 2012	Nov 2012 – Mar 2013	Jan – Mar 2013	Apr/May 2013	May 2013
Feed Enrolment	Self Test	Open Test	Certification Test	Market Rehearsal	Post Release Test
• Choice of Feed • Complimentary Feed (Yes/No) • Retransmission (Yes/No) • Choice of Batch (1st/2nd/3rd)	• On-boarding tools provided by HKEx, including real-time multicast simulator, canned data, user guide • First cut canned data for data decoding • Subsequent cut including more test scenarios, e.g. for order book building • Retransmission enabled • Refresh not supported	• Clients to arrange testing line installation • Conducted in HKEx testing environment with OMD Securities and Index fully functional, e.g. real-time data transmission via multicast channels, refresh and retransmission are all supported • Loop test with AMS/3.8 can be enabled	• Clients enabled to verify and declare their readiness for OMD Securities and Index in areas below: 1. message decoding 2. order book building 3. data recovery 4. volume/stress 5. site failover • Certification Test Document to be delivered in due course • Expected results to be provided for Clients' self verification • Self Declaration	• Volume test session • Self Declaration	• Self Declaration • 2 weeks' stabilisation period

On Boarding Activities

Subsequent Batches

Tentative Schedule



- **Parallel Run Fee Waiver**
  - **1st Batch: 3 month parallel run of OMD datafeed(s) and MDF 3.8 with a waiver on MDF 3.8 Redistribution Fee and Connection fee will be granted.**
  - **Shorter free parallel run will be given for subsequent batch rollout.**
    - **2nd Batch: Waiver on MDF 3.8 Redistribution Fee and Connection Fee will only be granted for the first 2-month parallel run of both MDF 3.8 and OMD datafeed(s).**
    - **3rd Batch: Clients will only have parallel run of MDF 3.8 and OMD datafeed(s) during the 2-week stabilization period.**

On Boarding Activities

Special Notes

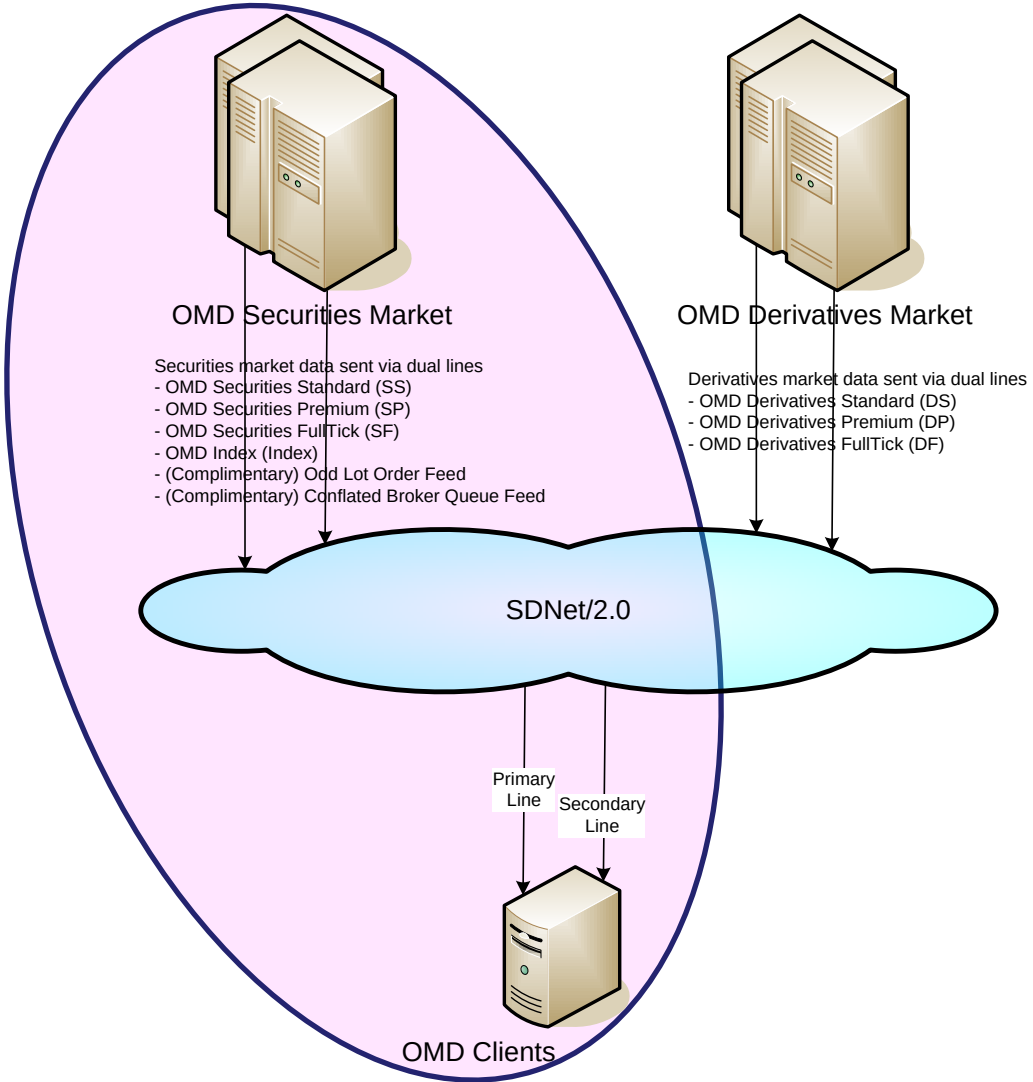
- **Decommissioning of MDF* and MDF 3.8**
  - **MDF* will be terminated upon lapse of 2-week stabilisation period of First Batch rollout.**
  - **MDF 3.8 will be terminated upon lapse of 2-week stabilisation period of Last Batch rollout.**
  - **Clients unable to migrate to the OMD in time will need to prepare for switching to contingency source, i.e. indirect connection via feed-providing vendors.**

- **Indirect Vendors Readiness**
  - **Feed providing vendors should ensure indirect connection vendors with OMD original format to pass the same test cases as per OMD direct connection clients.**
  - **Declaration of indirect connection vendor's readiness via both feed providing vendors and indirect connection vendor itself.**

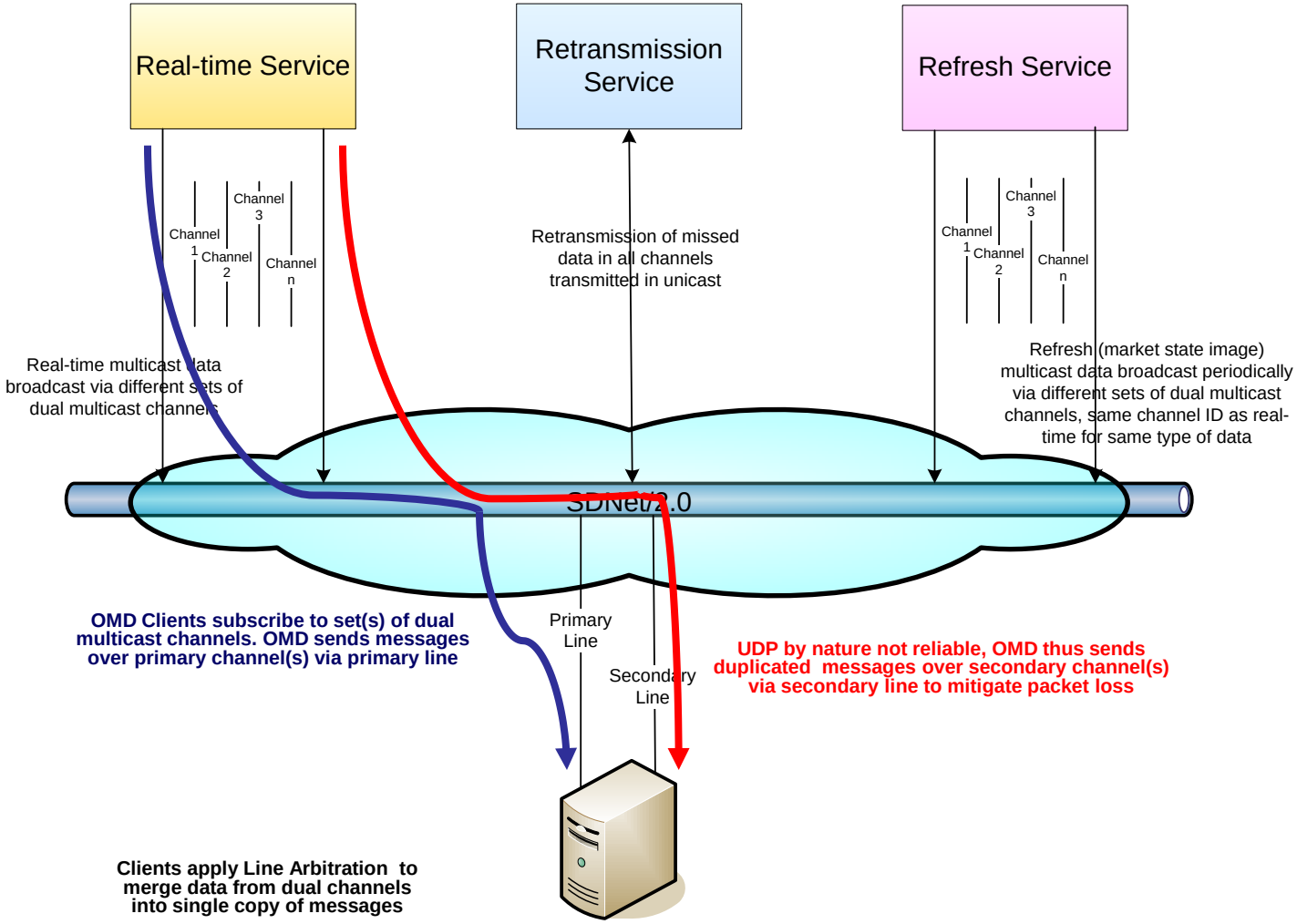
AGENDA – Part 2

1. **Overview of OMD**
2. Use of Developers Guide
3. Channel Assignment
4. Control Message
5. Recovery Mechanism
6. OMD Failure Recovery
7. Market Data Message
8. Highlights on Aggregate Order Book Management

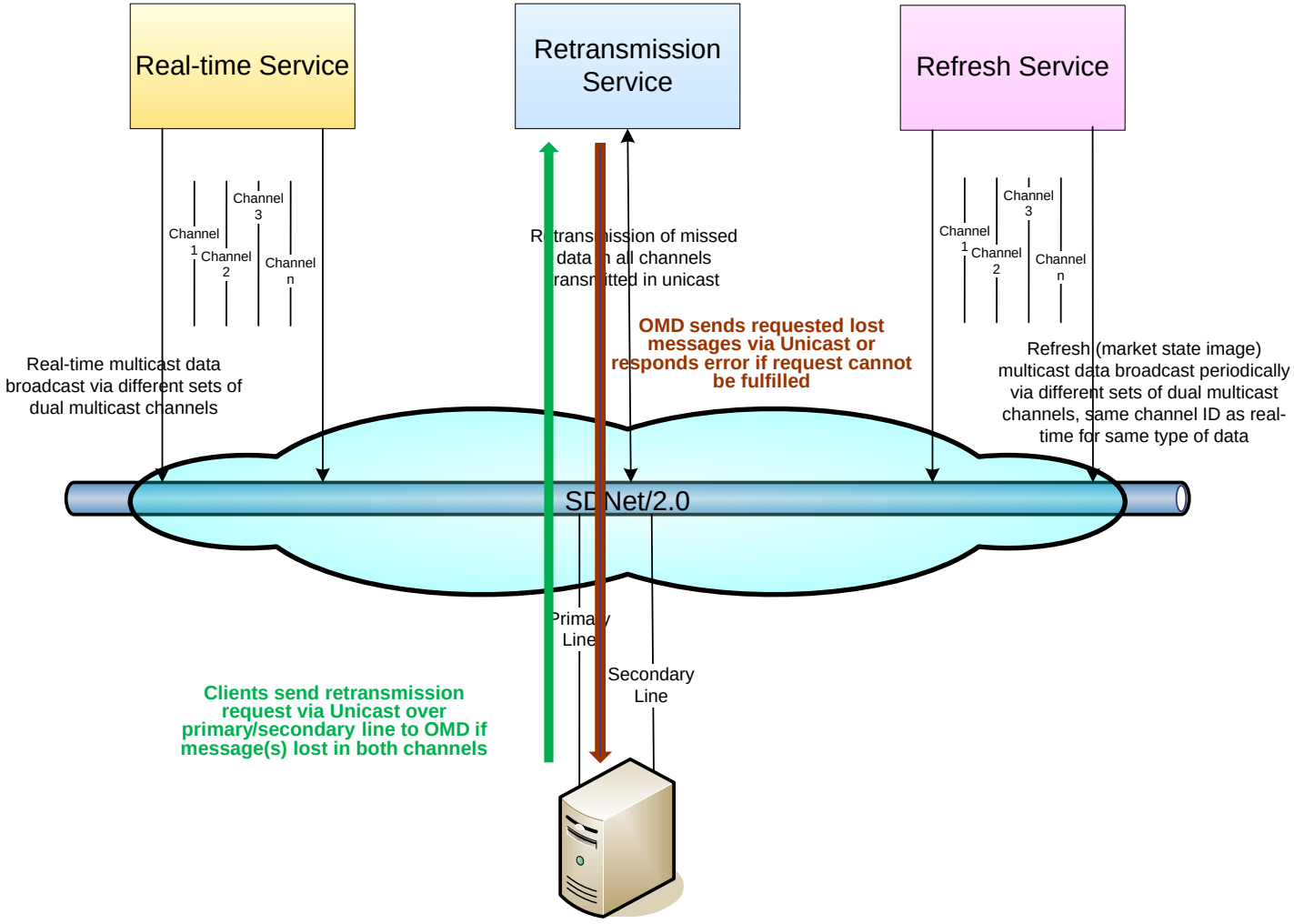
Overview of OMD



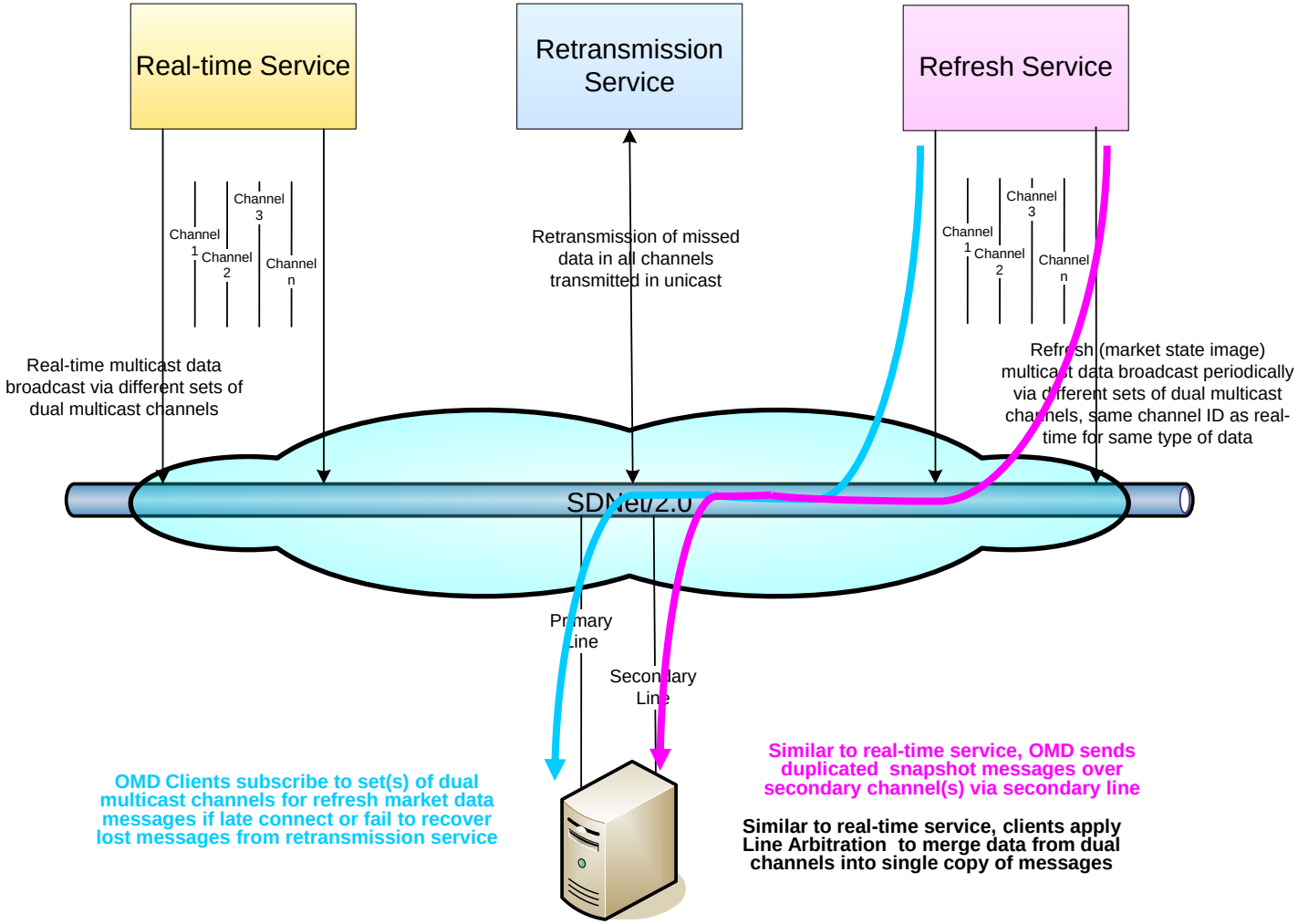
Overview of OMD



Overview of OMD



Overview of OMD



Overview of OMD

- Messages published in one-to-many mode using IP multicast and UDP transport protocols, supported by retransmission & retransmission services
- Duplicated messages sent over dual multicast channels via primary & secondary SDNet/2 lines, line arbitration applied
- Retransmission service offered for recovery of few lost packets in dual multicast channels
- Refresh service published snapshot market state using IP multicast and UDP transport protocols, line arbitration applied
- OMD adopt multicast in order to achieve
  - Fairness
  - Low latency
  - Small footprint in OMD host

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Use of Developers Guide

- Provide supplementary information to clients to support development of their own feed handler to process OMD messages
- Address potential queries raised by clients after reading OMD Interface Specification
- Help clients to get familiar with multicast message handling
- Cover different topics in deeper level of details to facilitate client development
  - Line Arbitration
  - Packet and message processing
  - Retransmission and refresh mechanism
  - Aggregate order book management and order book maintenance
  - Exception handling

Use of Developers Guide

- Illustrate with flow diagrams the possible logics in processing
  - Retransmitted data from OMD retransmission server
  - Refresh snapshot messages from OMD refresh service
- Demonstrate with pseudo codes as examples for message processing & exception handling
  - Connect and receive multicast channel
  - Line Arbitration
  - Processing retransmitted data
  - Processing refresh snapshot packet
  - Processing Aggregate Order Book message
- Objectives – use with OMD on-boarding tools to assist clients in OMD on-boarding

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Multicast Channel Assignment

- **OMD Securities Standard (SS)**

Multicast Service	Contents	Real-time Service Channel ID	Refresh Service Channel ID
Securities Static Data Channel	*Market Definition (10)* *Currency Rate (14)* *Security Definition (11)* *Liquidity Provider (13)*	1	501
Securities Status Channel	*Trading Session Status (20)* *Security Status (21)*	2	502
Securities Value Add Data Channel	*Market Turnover (61)*	3	503
Securities News Channel	*News (22)*	4	504
Securities Level 2 Conflated Channel	*Trade Ticker (52)* *Nominal Price (40)* *Indicative Equilibrium Price (41)* *Closing Price (62)* *Aggregate Order Book Update (53)* *Statistics (60)* *Yield (44)*	10	510
Securities Market Broker Queue Channel	*Broker Queue (54)*	60	560

Multicast Channel Assignment

- **OMD Securities Premium (SP)**

Multicast Service	Contents	Real-time Service Channel ID	Refresh Service Channel ID
Securities Static Data Channel	*Market Definition (10)* *Currency Rate (14)* *Security Definition (11)* *Liquidity Provider (13)*	1	501
Securities Status Channel	*Trading Session Status (20)* *Security Status (21)*	2	502
Securities Value Add Data Channel	*Market Turnover (61)*	3	503
Securities News Channel	*News (22)*	4	504
Securities Level 2 Streaming Channel	*Trade (50)* *Trade Cancel (51)* *Nominal Price (40)* *Indicative Equilibrium Price (41)* *Closing Price (62)* *Aggregate Order Book Update (53)* *Statistics (60)* *Yield (44)*	20 – 28	520 – 528

Multicast Channel Assignment

- **OMD Securities FullTick (SF)**

Multicast Service	Contents	Real-time Service Channel ID	Refresh Service Channel ID
Securities Static Data Channel	*Market Definition (10)* *Currency Rate (14)* *Security Definition (11)* *Liquidity Provider (13)*	1	501
Securities Status Channel	*Trading Session Status (20)* *Security Status (21)*	2	502
Securities Full Book Channel	*Trade (50)* *Trade Cancel (51)* *Add Order (30)* *Modify Order (31)* *Delete Order (32)* *Indicative Equilibrium Price (41)*	30 – 38	530 – 538

Multicast Channel Assignment

- **OMD Index (Index)**

Multicast Service	Contents	Real-time Service Channel ID	Refresh Service Channel ID
Hang Seng Index Channel	*Index Definition (70)* *Index Data (71)*	41	541
CSIC Index Channel	*Index Definition (70)* *Index Data (71)*	42	542
S&P Index Channel	*Index Definition (70)* *Index Data (71)*	43	543

Multicast Channel Assignment

- **(Complimentary) Odd Lot Order Feed**

Multicast Service	Contents	Real-time Service Channel ID	Refresh Service Channel ID
Securities Market Odd Lot Full Book Channel	*Add Odd Lot Order (33)* *Delete Odd Lot Order (34)*	70 – 78	570 – 578

- **(Complimentary) Conflated Broker Queue Feed**

Multicast Service	Contents	Real-time Service Channel ID	Refresh Service Channel ID
Securities Market Conflated Broker Queue Channel	*Broker Queue (54)*	60	560

Multicast Channel Assignment

- **Product-Channel Mapping**

Multicast Service	Product	Real-time Service Channel ID	Refresh Service Channel ID
Securities Static Data Channel	SS SP SF	1	501
Securities Status Channel	SS SP SF	2	502
Securities Value Add Data Channel	SS SP	3	503
Securities News Channel	SS SP	4	504
Securities Level 2 Conflated Channel	SS	10	510
Securities Market Broker Queue Channel	SS SP (Complimentary)	60	560

Multicast Channel Assignment

- **Product-Channel Mapping (con't)**

Multicast Service	Product	Real-time Service Channel ID	Refresh Service Channel ID
Securities Level 2 Streaming Channel	SP	20 – 28	520 – 528
Securities Full Book Channel	SF	30 – 38	530 – 538
Hang Seng Index Channel	Index	41	541
CSIC Index Channel	Index	42	542
S&P Index Channel	Index	43	543
Securities Market Odd Lot Full Book Channel	SS (Complimentary) SP (Complimentary) SF (Complimentary)	70 – 78	570 – 578

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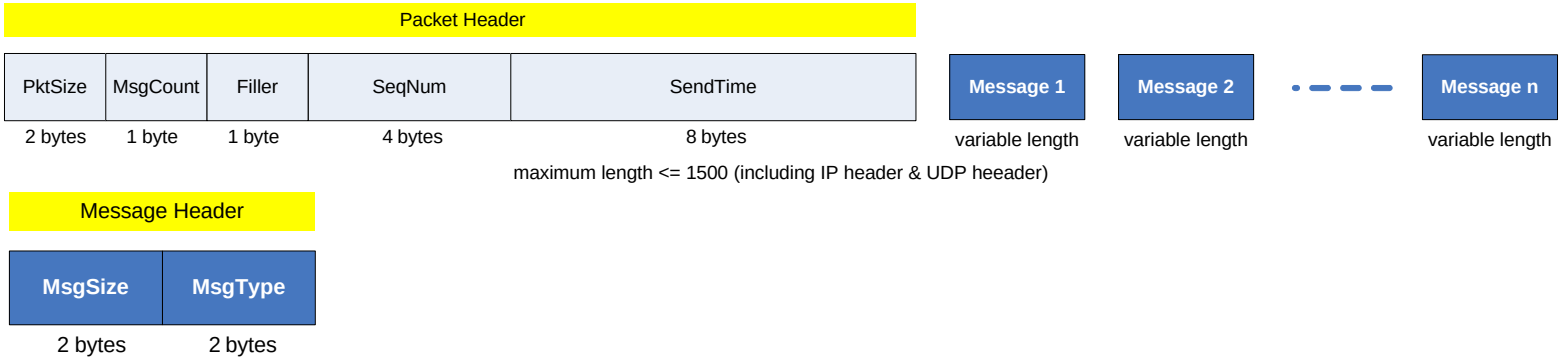
Control Message

- **Multicast packet structured into a Packet Header followed by 0 or more messages, each starts with a 4-byte Message Header**



  - **Same packet structure applied to unicast messages**

- **There are 2 kinds of messages in OMD**
  - **Control message**
    - ***Heartbeat*, *Sequence Reset (100)*, *Refresh Complete (203)*, *Logon (101) & Logon Response (102)*, *Retransmission Request (201) & Retransmission Response (202)***
  - **Market Data message**

Control Message

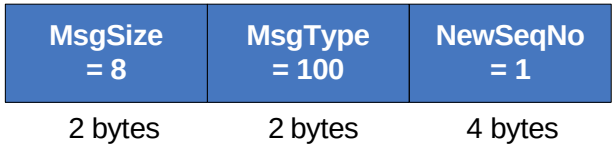
- **Heartbeat**
  - **Unique message in a packet with MsgCount 0**

Field	Value
PktSize	16
MsgCount	0
Filler	
SeqNum	Sequence number of previous message
SendTime	Send time of the heartbeat

  - **Heartbeat frequency**
    - **Multicast – 2 seconds**
    - **Unicast**
      - **30 seconds**
      - **Need response in 5 seconds otherwise TCP/IP session will be terminated**
      - **Heartbeat response from clients is an exact copy of the incoming heartbeat**

Control Message

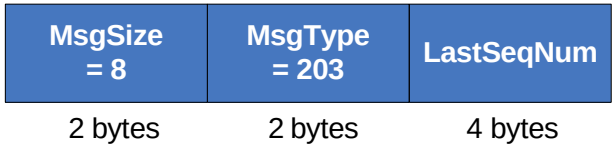
- **Sequence Reset (100)**



  - Per channel in real-time & refresh
  - Once at Start of Day, multiple for resend of Reference data under very rare condition – this apply to real-time channel only
  - Possible sent following OMD failure recovery
  - Set next expected sequence number to 1
  - Processing highlights to be covered in next topic

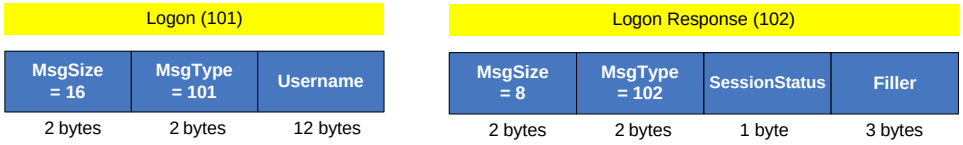
Control Message

- **Refresh Complete (203)**



  - As a marker between successive full refresh snapshots
  - Clients cache real-time data before full refresh snapshots received
  - Process real-time data with sequence number greater than LastSeqNum and discard the rest

- **Logon (101) & Logon Response (102)**



  - Authenticate Username & client IP
  - Reject logon for duplicated logon, invalid username or client IP
  - *Logon* / *Logon Response* timeout – 5 seconds

Control Message

- **Retransmission Request (201) & Retransmission Response (202)**

Retransmission Request (201)

MsgSize = 16	MsgType = 201	ChannelID	Filler	BeginSeqNum	EndSeqNum
2 bytes	2 bytes	2 bytes	2 bytes	4 bytes	4 bytes

Retransmission Response (202)

MsgSize = 16	MsgType = 202	ChannelID	RetransStatus	Filler	BeginSeqNum	EndSeqNum
2 bytes	2 bytes	2 bytes	1 byte	1 byte	4 bytes	4 bytes

- **Requested messages will be sent after successful *Retransmission Response***
- **SeqNum in packet header carries no meaning, simply ignore it**
- **BeginSeqNum & EndSeqNum in *Retransmission Response* copied from *Retransmission Request*, carry no meaning & can be ignored**

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5. **Recovery Mechanism**
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Recovery Mechanism

- UDP protocol is unreliable & exposed to risk of packet loss
- Infrastructure-wise SNDet/2 offers extremely low packet loss rate ➔ compensate UDP shortfall
- Clients may still experience, though some are rare:
  - Late connection
  - Client application restarts
  - OMD restart or node/site failover
- To address the above OMD implements below different recovery mechanisms:
  - Line Arbitration
  - Retransmission Service
  - Refresh Service

Recovery Mechanism – Line Arbitration

- **Data broadcast in different sets of dual multicast channels via primary line (Line A) & secondary line (Line B)**
- **Content comparison for Line A & Line B**

Identical	(Possible) Difference
Sequence number (SN)	Number of message in a packet (MsgCount)
Messages that are sent	SN of 1st message in the packet (SeqNum)
Sequence of the message sent	

- **Contents of Line A & Line B can be**

Line A		
Message	**MsgCount**	**SeqNum**
Add Order 1 Add Order 2 Modify Order 1	3	101
Trade 1 Delete Order 1	2	104
Trade 2 Statistics 1	2	106

Line B		
Message	**MsgCount**	**SeqNum**
Add Order 1 Add Order 2	2	101
Modify Order 1 Trade 1 Delete Order 1	3	103
Trade 2 Statistics 1	2	106

Recovery Mechanism – Line Arbitration

- Listen to both Line A & Line B, set same priority for both lines
- Whenever a gap is detected in Line A or Line B, either
  - Wait some finite time, issue retransmission request if gap cannot be filled from same line (due to out of order) or alternate line
  - Issue retransmission request directly
- Gap detection mechanism may work as follows
  - Set next expected sequence number (NSN) to s+1, assuming
    - Sequence number (SN) of last message in $(n-1)^{th}$ packet = s
    - No gap detected in (n-1) packets
  - For each message in n^{th} packet compare message SN with NSN
    - If SN = NSN, process message, advance SN & NSN by 1
    - Duplicate message if SN < NSN ➔ discard message
    - Gap detected if SN > NSN

Recovery Mechanism – Retransmission Service

- Recover small number of message gap (real-time feed only)
- Primary/secondary retransmission server (RTS) for resilience
- Clients can establish connection to RTS when their system starts up or when retransmission is needed
- Check heartbeat to detect connection drop, reconnect to same RTS or switch to secondary RTS
- Missing messages sent in packets not exceeding 1,500 bytes
- Several limits to take note

System Limit	Value
Available number of messages per channel ID	50,000
Maximum sequence range for request per channel ID	10,000
Daily maximum of requests (counting all channel IDs)	1,000

Recovery Mechanism – Retransmission Service

- Cache real-time data & process after gap filled
- Multiple gaps may occur in same channel while a gap awaiting filled or occur in different channels
  - Keep a list of gaps to be filled
  - Process distinct retransmission request/response with RTS to fill gap one by one
  - RTS accepts multiple concurrent requests from same client
    - FIFO
    - May interleave with requests from other clients
    - ***Clients should send new request to RTS only after previous gap is filled***
- Use refresh service if gap size exceeds available number of messages in the channel

Recovery Mechanism – Refresh Service

- Allow clients to late connect to OMD or recover from significant packet loss
- Publish latest market states periodically in for the followings:
  - Latest images of all reference data & index definition
  - Latest snapshots for each security/market/index
    - Market & halted securities status
    - Market & securities statistics and securities prices data
    - Aggregate order book updates & broker queue
    - Outstanding orders in board lot & odd lot books
    - Last non-cancelled trade/trade ticker
    - Index data
  - All news

Recovery Mechanism – Refresh Service

- Refresh processing may work as follows
  - Clear all cached market data before processing refresh data
  - Cache real-time data to be processed after refresh complete
  - First build market/securities/index static images from refresh channels for reference data before listen to other channels
  - Line Arbitration for real-time data applies to refresh data except
    - No retransmission service
    - No need to check any message gap before first arrived packet
  - Any gap cannot be filled from same/alternate line ➔ discard the cached data & wait for next 'full' refresh snapshot

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OMD Failure Recovery

- OMD builds different levels of resilience to address the followings:
  - SDNet/2 client line failure – dual client lines
  - SDNet/2 host line failure – multiple host lines
  - OMD node failure – dual nodes for node restart/failover
  - OMD site failure – primary & DR sites for site failover
- Apply below recovery mechanisms for SDNet/2 client/host line failure or OMD node restart
  - Line Arbitration
  - Retransmission Service
  - Refresh Service

OMD Failure Recovery

- **Apply same recovery mechanism for node failure except for**
  - **SS clients to check ticker ID to avoid duplication for possible sending of duplicated trade tickers from OMD**
- **Clients may receive *Sequence Reset* messages when OMD node restarts or fails over to DR site**
  - **Sequence reset processing may work as follows:**
    - **Receive *Sequence Reset* message from any multicast channel, ignore subsequent *Sequence Reset* messages from other channels**
    - **Reset next expected sequence number to 1 for all channels**
    - **Clear all cached data for all instruments**
    - **Subscribe to refresh channels for latest market states**
    - **Resume to process real-time messages**

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Market Data Message

Message Overview

Reference Data
Market Definition (10)
Security Definition (11)
Liquidity Provider (13)
Currency Rate (14)

Status Data
Trading Session Status (20)
Security Status (21)

Order Book Data
Add Order (30)
Modify Order (31)
Delete Order (32)
Add Odd Lot Order (33)
Delete Odd Lot Order (34)
Aggregate Order Book Update (53)
Broker Queue (54)

Trade and Price Data
Trade (50)
Trade Cancel (51)
Trade Ticker (52)
Closing Price (62)
Nominal Price (40)
Indicative Equilibrium Price (41)

Value Added Data
Statistics (60)
Market Turnover (61)
Yield (44)

News
News (22)

Index Data
Index Definition (70)
Index Data (71)

Market Data Message

- **Spread table is not OMD reference data, clients should reference to below link to build its own for spread compilation**

  http://www.hkex.com.hk/eng/rulesreg/traderules/sehk/documents/sch-2_eng.pdf

- **3 decimal places implied for all prices and turnovers market data except**
  - **CurrencyRate in *Currency Rate* – 4 implied decimal places**
  - **EAS in *Index Data* – 2 implied decimal places**
  - **Indexes & turnovers in *Index Data* – 4 implied decimal places**
- **All time fields are in number of elapsed µs since midnight Jan 1, 1970 (UTC), convert to the date-time format if needed**

Market Data Message

- **Highlights of some market data messages provided in subsequent slides to help clients in system development**
- **Reference Data**
  - **Market Definition (10)**
    - **Clients can use NumberOfSecurities to check against the number of securities received from *Security Definition (11)* for each of the market**
  - **Securities Definition (11)**
    - **Variable message size depending on NoUnderlyingSecurities, varies from 280 to 440 bytes**
    - **NoUnderlyingSecurities can be 0 or 1 for Warrants and Structured Product, or 0 to 20 for Basket Warrants**
    - **Clients may receive this message for some securities during trading hours if there are changes to some of the fields, e.g. FreeText**
    - **Clients should ignore data in fields not applicable to the instrument being processed, e.g. Style for Basket Warrants only**

Market Data Message

- Liquidity Provider (13)
  - Message is of variable size depending on NoLiquidityProviders
  - Send only for securities having liquidity providers
- Currency Rate (14)
  - Mainly for SF clients to calculate the market turnover in HKD
  - Clients will not receive this message during trading hours

Status Data

- Trading Session Status (20)
  - TradingSesControlFlag normally set to '0' (auto control), set to '1' (manual control) only for weekend test or some special scenarios like No. 8 typhoon signal hoisting
  - When TradingSesControlFlag set to '1' clients should refer to StartDateTime & EndDateTime for the session schedule if applicable

Market Data Message

- Security Status (21)
  - At Start of Day (SOD), clients should set all security statuses to active
  - Set security status to suspended/halted when receiving this message at SOD, which are only be sent when a security is suspended/halted

- Order Book Data
  - Add Order (30), Modify Order (31), Delete Order (32)
    - Not available in Auction Session until completion of auction
    - OMD sends board lot order book state delta change in one or more of these 3 messages for SF clients to build their own book
    - Orders are uniquely identified by SecurityCode + OrderID
  - Add Odd Lot Order (33), Delete Odd Lot Order (34)
    - Not available in Auction Session until completion of auction
    - No Modify Order for odd lot
    - Difference from board lot order book messages – extra BrokerID field

Market Data Message

- **Broker Queue (54)**
  - Message is of variable size depending on ItemCount
  - BQMoreFlag set on when the broker/spread information for o/s orders in board lot book exceeds the 40 entries in the message
  - Type S only sent from 2nd best bid/ask spread, not for best bid/ask
  - Item set to 0 with Type set to S when there is no order queued for a spread, otherwise Item set to broker number(s) with Type set to B
- **Aggregate Order Book Update (53)**
  - Message is of variable size depending on NoEntries
  - Send delta change instead of full 10BBO to reduce bandwidth usage
  - Use PriceLevel instead of Tick Level to follow international practice
  - Processing highlights to be covered in next topic

Market Data Message

- **Trade and Price Data**
  - **Trade (50)**
    - Trades are uniquely identified by SecurityCode + TradeID
    - Overseas trades are identified with TrdType 104
  - **Trade Ticker (52)**
    - Trade tickers are uniquely identified by SecurityCode + TickerID
    - Overseas trade tickers are identified with TrdType 104 which are not distinguished in current MDF 3.8 feed
  - **Closing Price (62)**
    - SS clients should ignore NumberOfTrades field which is not available

Market Data Message

- Nominal Price (40)
  - SF clients should derive their own nominal price according to Trading Rules in HKEx website, if needed
- Indicative Equilibrium Price (41)
  - Price & AggregateQuantity continuously updated during auction session
  - These 2 fields set to 0 after auction matching completed after updated to NominalPrice in *Nominal Price* and SharesTraded in *Statistics*
  - NominalPrice will be set to nonzero IEP during auction session

Value Added Data

- Statistics (60)
  - SS clients should ignore VWAP field which is not available
  - ShortSellSharesTraded & ShortSellTurnover sent twice a day to replace existing data sent as ShortSell news in MDF 3.8 feed

Market Data Message

- **News**
  - **News (22)**
    - Message is of variable size depending on NoMarketCodes, NoSecurityCodes & NoNewsLines
    - Multiple *News* messages
      - When news content cannot fit into a single *News* message
      - Last news message when LastFragment set to "Y"
      - Maximum 7 news lines can fit into a news message
- **Index Data**
  - **Index Definition (70)**
    - CurrencyCode can be blank if not defined by third party index compiler – only CSIC defines currency code for its indexes
    - OMD Index supplies 5 HSI indexes + 4 sub-indexes, 23 CSI indexes and 2 S&P indexes

Market Data Message

- **Index Data (71)**
  - **OMD receives index data from third party index compiler and sends immediately to clients 'as is', except for HSI indexes:**
    - **Set not available fields in current snapshot (HighValue & LowValue and/or EASValue and/or IndexTurnover) to null value (0x8000000000000000)**
  - **IndexStatus can be blank if not defined by third party index compiler – only CSIC does not define index status**
  - **Clients should ignore data in fields not applicable to the index being processed, e.g. Exception for HSI indexes only**

AGENDA – Part 2

1. Overview of OMD
2. Use of Developers Guide
3. Channel Assignment
4. Control Message
5. Recovery Mechanism
6. OMD Failure Recovery
7. Market Data Message
8. **Highlights on Aggregate Order Book Management**

Highlights on Aggregate Order Book Management

- **Tick Level vs Price Level**

Tick Level	Price Level
Defined as how many spreads from the best bid/ask price	Assigned to each price existing in the OMD order book
A tick level of 10 means the order price is 9 spreads from the best price	A price level of 10 means the order price is the 10th best prices in the order book
Used in MDF 3.8 and AMS/3.8	Widely used in other Exchanges
MDF 3.8 sends tick level in XO element	OMD sends price level in message (53)
Empty tick level is possible	No empty price level

- **Relationship between Tick Level & Price Level shown below**
  - **Assume**
    - **Security code = 1234**
    - **Best bid price @ 9.8000**
    - **Spread = 0.01 at this price**
  - **Top 5 bid prices (5 Price Levels) spread across 10 Tick Levels**
  - **OMD sends message (53) to allow clients maintain their aggregate order books for 10 Tick Levels at most**

Bid Side			
Tick	PriceLevel	AggregateQuantity	Price
1	1	700	9.800
2	2	350	9.790
3			
4			
5	3	150	9.760
6			
7			
8			
9	4	250	9.720
10	5	100	9.710

Highlights on Aggregate Order Book Management

- **Illustration of different techniques used for processing *Aggregate Order Book Update,* take SS as reference**
  - **At time T we have the following OMD book image**

Bid Side				Ask Side			
Tick	PriceLevel	AggregateQuantity	Price	Price	AggregateQuantity	PriceLevel	Tick
1	1	250	9.730	9.800	700	1	1
2	2	50	9.720	9.810	350	2	2
3	3	700	9.710	9.820	150	3	3
4	4	350	9.700				4
5	5	150	9.690	9.840	250	4	5
6	6	250	9.680	9.850	100	5	6
7	7	100	9.670				7
8	8	150	9.660	9.870	400	6	8
9	9	50	9.650	9.880	200	7	9
10	10	150	9.640	9.890	300	8	10
11	11	100	9.630				11
12							12
13							13
14							14
15							15
16							16

  - **At time T+1 we have the following sequence events:**
    - **(1) An aggressing ask order @ 9.730 completely matched resting bid order @ tick level 1;**
    - **(2) A modify order to reduce resting order quantity @ tick level 3 from 700 to 300;**
    - **(3) New ask orders at 3 different prices (9.740, 9.750 & 9.760) arrived**

Highlights on Aggregate Order Book Management

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- OMD sends the following Aggregate Order Book Update message

Offset	Field Name	Value
0	MsgSize	252
2	MsgType	53
4	SecurityCode	1234
8	Filler	NULL
11	NoEntries	10
12	AggregateQuantity	250
20	Price	9.730
24	NumberOfOrders	1
28	Side	0 (Bid)
30	PriceLevel	1
31	UpdateAction	2
32	Filler	NULL
36	AggregateQuantity	300
44	Price	9.710
48	NumberOfOrders	1
52	Side	0 (Bid)
54	PriceLevel	2
55	UpdateAction	1
56	Filler	NULL
60	AggregateQuantity	100
68	Price	9.630
72	NumberOfOrders	1
76	Side	0 (Bid)
78	PriceLevel	10
79	UpdateAction	1
80	Filler	NULL
84	AggregateQuantity	450
92	Price	9.740
96	NumberOfOrders	1
100	Side	1 (Offer)
102	PriceLevel	1
103	UpdateAction	0
104	Filler	NULL
108	AggregateQuantity	550
116	Price	9.750
120	NumberOfOrders	1
124	Side	1 (Offer)
126	PriceLevel	2
127	UpdateAction	0
128	Filler	NULL
132	AggregateQuantity	650
140	Price	9.760
144	NumberOfOrders	1
148	Side	1 (Offer)
150	PriceLevel	3
151	UpdateAction	0
152	Filler	NULL
156	AggregateQuantity	250
164	Price	9840
168	NumberOfOrders	1
172	Side	1 (Offer)
174	PriceLevel	7
175	UpdateAction	2
176	Filler	NULL
180	AggregateQuantity	100
188	Price	9850
192	NumberOfOrders	1
196	Side	1 (Offer)
198	PriceLevel	8
199	UpdateAction	2
200	Filler	NULL
204	AggregateQuantity	400
212	Price	9870
216	NumberOfOrders	1
220	Side	1 (Offer)
222	PriceLevel	9
223	UpdateAction	2
224	Filler	NULL
228	AggregateQuantity	200
236	Price	9880
240	NumberOfOrders	1
244	Side	1 (Offer)
246	PriceLevel	10
247	UpdateAction	2
248	Filler	NULL

Highlights on Aggregate Order Book Management

Bid Side				Ask Side			
Tick	PriceLevel	AggregateQuantity	Price	Price	AggregateQuantity	PriceLevel	Tick
1	[redacted]			9.800	700	1	1
2	2	50	9.720	9.810	350	2	2
3	3	700	9.710	9.820	150	3	3
4	4	350	9.700				4
5	5	150	9.690	9.840	250	4	5
6	6	250	9.680	9.850	100	5	6
7	7	100	9.670				7
8	8	150	9.660	9.870	400	6	8
9	9	50	9.650	9.880	200	7	9
10	10	150	9.640	9.890	300	8	10
11	11	100	9.630				11
12							12
13							13
14							14
15							15
16							16

12	AggregateQuantity	250
20	Price	9.730
24	NumberOfOrders	1
28	Side	0 (Bid)
30	PriceLevel	1
31	UpdateAction	2
32	Filler	NULL

1st aggregate book order update entry

Explicit Deletion

Implicit Level Adjustment
Change Price Levels
from 2 – 10 to 1 – 9 (by clients)

Bid Side				Ask Side			
Tick	PriceLevel	AggregateQuantity	Price	Price	AggregateQuantity	PriceLevel	Tick
1	1	50	9.720	9.740	450	1	1
2	2	300	9.710	9.750	550	2	2
3	3	350	9.700	9.760	650	3	3
4	4	150	9.690				4
5	5	250	9.680				5
6	6	100	9.670				6
7	7	150	9.660	9.800	700	4	7
8	8	50	9.650	9.810	350	5	8
9	9	150	9.640	9.820	150	6	9
10	10	100	9.630				10
11				9.840	250	7	11
12				9.850	100	8	12
13							13
14				9.870	400	9	14
15				9.880	200	10	15
16				9.890	300	11	16

Highlights on Aggregate Order Book Management

Bid Side				Ask Side			
Tick	PriceLevel	AggregateQuantity	Price	Price	AggregateQuantity	PriceLevel	Tick
1	1	250	9.730	9.800	700	1	1
2	2	50	9.720	9.810	350	2	2
3	3	700	9.710	9.820	150	3	3
4	4	350	9.700				4
5	5	150	9.690	9.840	250	4	5
6	6	250	9.680	9.850	100	5	6
7	7	100	9.670				7
8	8	150	9.660	9.870	400	6	8
9	9	50	9.650	9.880	200	7	9
10	10	150	9.640	9.890	300	8	10
11	11	100	9.630				11
12							12
13							13
14							14
15							15
16							16

Order Reduction

2nd aggregate book order update entry

36	AggregateQuantity	300
44	Price	9.710
48	NumberOfOrders	1
52	Side	0 (Bid)
54	PriceLevel	2
55	UpdateAction	1
56	Filler	NULL

Bid Side				Ask Side			
Tick	PriceLevel	AggregateQuantity	Price	Price	AggregateQuantity	PriceLevel	Tick
1	1	50	9.720	9.740	450	1	1
2	2	300	9.710	9.750	550	2	2
3	3	350	9.700	9.760	650	3	3
4	4	150	9.690				4
5	5	250	9.680				5
6	6	100	9.670				6
7	7	150	9.660	9.800	700	4	7
8	8	50	9.650	9.810	350	5	8
9	9	150	9.640	9.820	150	6	9
10	10	100	9.630				10
11				9.840	250	7	11
12				9.850	100	8	12
13							13
14				9.870	400	9	14
15				9.880	200	10	15
16				9.890	300	11	16

Highlights on Aggregate Order Book Management

Bid Side				Ask Side			
Tick	PriceLevel	AggregateQuantity	Price	Price	AggregateQuantity	PriceLevel	Tick
1	1	250	9.730	9.800	700	1	1
2	2	50	9.720	9.810	350	2	2
3	3	700	9.710	9.820	150	3	3
4	4	350	9.700				4
5	5	150	9.690	9.840	250	4	5
6	6	250	9.680	9.850	100	5	6
7	7	100	9.670				7
8	8	150	9.660	9.870	400	6	8
9	9	50	9.650	9.880	200	7	9
10	10	150	9.640	9.890	300	8	10
11	11	100	9.630				11
12							12
13							13
14							14
15							15
16							16

Explicit Addition
After best bid order matched , original order @ tick level 11 becomes tick level 10
→ OMD sends 'new' entry for the 10th tick

3rd aggregate book order update entry

60	AggregateQuantity	100
68	Price	9.630
72	NumberOfOrders	1
76	Side	0 (Bid)
78	PriceLevel	10
79	UpdateAction	1
80	Filler	NULL

Bid Side				Ask Side			
Tick	PriceLevel	AggregateQuantity	Price	Price	AggregateQuantity	PriceLevel	Tick
1	1	50	9.720	9.740	450	1	1
2	2	300	9.710	9.750	550	2	2
3	3	350	9.700	9.760	650	3	3
4	4	150	9.690				4
5	5	250	9.680				5
6	6	100	9.670				6
7	7	150	9.660	9.800	700	4	7
8	8	50	9.650	9.810	350	5	8
9	9	150	9.640	9.820	150	6	9
10	10	100	9.630				10
11				9.840	250	7	11
12				9.850	100	8	12
13							13
14				9.870	400	9	14
15				9.880	200	10	15
16				9.890	300	11	16

Highlights on Aggregate Order Book Management

Bid Side				Ask Side			
Tick	PriceLevel	AggregateQuantity	Price	Price	AggregateQuantity	PriceLevel	Tick
1	1	250	9.730	9.800	700	1	1
2	2	50	9.720	9.810	350	2	2
3	3	700	9.710	9.820	150	3	3
4	4	350	9.700				4
5	5	150	9.690	9.840	250	4	5
6	6	250	9.680	9.850	100	5	6
7	7	100	9.670				7
8	8	150	9.660	9.870	400	6	8
9	9	50	9.650	9.880	200	7	9
10	10	150	9.640	9.890	300	8	10
11	11	100	9.630				11
12							12
13							13
14							14
15							15
16							16

84	AggregateQuantity	450
92	Price	9.740
96	NumberOfOrders	1
100	Side	1 (Offer)
102	PriceLevel	1
103	UpdateAction	0
104	Filler	NULL

4th aggregate book order update entry

Explicit Addition

Bid Side				Ask Side			
Tick	Price	AggregateQuantity	Price	Price	AggregateQuantity	PriceLevel	Tick
1				9.740	450	1	1
2	2		9.710	9.750	550	2	2
3	3	350	9.700	9.760	650	3	3
4	4	150	9.690				4
5	5	250	9.680				5
6	6	100	9.670				6
7	7	150	9.660	9.800	700	4	7
8	8	50	9.650	9.810	350	5	8
9	9	150	9.640	9.820	150	6	9
10	10	100	9.630				10
11				9.840	250	7	11
12				9.850	100	8	12
13							13
14				9.870	400	9	14
15				9.880	200	10	15
16				9.890	300	11	16

Highlights on Aggregate Order Book Management

Bid Side				Ask Side			
Tick	PriceLevel	AggregateQuantity	Price	Price	AggregateQuantity	PriceLevel	Tick
1	1	250	9.730	9.800	700	1	1
2	2	50	9.720	9.810	350	2	2
3	3	700	9.710	9.820	150	3	3
4	4	350	9.700				4
5	5	150	9.690	9.840	250	4	5
6	6	250	9.680	9.850	100	5	6
7	7	100	9.670				7
8	8	150	9.660	9.870	400	6	8
9	9	50	9.650	9.880	200	7	9
10	10	150	9.640	9.890	300	8	10
11	11	100	9.630				11
12							12
13							13
14							14
15							15
16							16

5th aggregate book order update entry

Explicit Addition

108	AggregateQuantity	550
116	Price	9.750
120	NumberOfOrders	1
124	Side	1 (Offer)
126	PriceLevel	2
127	UpdateAction	0
128	Filler	NULL

Bid Side				Ask Side			
Tick	PriceLevel	AggregateQuantity	Price	Price	AggregateQuantity	PriceLevel	Tick
1	1	50	9.720	9.740	450	1	1
2	2	300	9.710	9.750	550	2	2
3	3	350	9.700	9.760	650	3	3
4	4	150	9.690				4
5	5	250	9.680				5
6	6	100	9.670				6
7	7	150	9.660	9.800	700	4	7
8	8	50	9.650	9.810	350	5	8
9	9	150	9.640	9.820	150	6	9
10	10	100	9.630				10
11				9.840	250	7	11
12				9.850	100	8	12
13							13
14				9.870	400	9	14
15				9.880	200	10	15
16				9.890	300	11	16

Highlights on Aggregate Order Book Management

Bid Side				Ask Side			
Tick	PriceLevel	AggregateQuantity	Price	Price	AggregateQuantity	PriceLevel	Tick
1	1	250	9.730	9.800	700	1	1
2	2	50	9.720	9.810	350	2	2
3	3	700	9.710	9.820	150	3	3
4	4	350	9.700				4
5	5	150	9.690	9.840	250	4	5
6	6	250	9.680	9.850	100	5	6
7	7	100	9.670				7
8	8	150	9.660	9.870	400	6	8
9	9	50	9.650	9.880	200	7	9
10	10	150	9.640	9.890	300	8	10
11	11	100	9.630				11
12							12
13							13
14							14
15							15
16							16

Implicit Level Adjustment
Change Price Levels
from 1 – 8 to 4 – 11 (by clients)

Explicit Addition

6th aggregate book order update entry

132	AggregateQuantity	650
140	Price	9.760
144	NumberOfOrders	1
148	Side	1 (Offer)
150	PriceLevel	3
151	UpdateAction	0
152	Filler	NULL

Bid Side				Ask Side			
Tick	PriceLevel	AggregateQuantity	Price	Price	AggregateQuantity	PriceLevel	Tick
1	1	50	9.720	9.740	450	1	1
2	2	300	9.710	9.750	550	2	2
3	3	350	9.700	9.760	650	3	3
4	4	150	9.690				4
5	5	250	9.680				5
6	6	100	9.670				6
7	7	150	9.660	9.800	700	4	7
8	8	50	9.650	9.810	350	5	8
9	9	150	9.640	9.820	150	6	9
10	10	100	9.630				10
11				9.840	250	7	11
12				9.850	100	8	12
13							13
14				9.870	400	9	14
15				9.880	200	10	15
16				9.890	300	11	16

Highlights on Aggregate Order Book Management

Bid Side				Ask Side			
Tick	PriceLevel	AggregateQuantity	Price	Price	AggregateQuantity	PriceLevel	Tick
1	1	250	9.730	9.800	700	1	1
2	2	50	9.720	9.810	350	2	2
3	3	700	9.710	9.820	150	3	3
4	4	350	9.700				4
5	5	150	9.690	9.840	250	4	5
6	6	250	9.680	9.850	100	5	6
7	7	100	9.670				7
8	8	150	9.660	9.870	400	6	8
9	9	50	9.650	9.880	200	7	9
10	10	150	9.640	9.890	300	8	10
11	11	100	9.630				11
12							12
13							13
14							14
15							15
16							16

156	AggregateQuantity	250
164	Price	9840
168	NumberOfOrders	1
172	Side	1 (Offer)
174	PriceLevel	7
175	UpdateAction	2
176	Filler	NULL

7th aggregate book order update entry

Explicit Deletion

Bid Side				Ask Side			
Tick	PriceLevel	AggregateQuantity	Price	Price	AggregateQuantity	PriceLevel	Tick
1	1	50	9.720	9.740	450	1	1
2	2	300	9.710	9.750	550	2	2
3	3	350	9.700	9.760	650	3	3
4	4	150	9.690				4
5	5	250	9.680				5
6	6	100	9.670				6
7	7	150	9.660	9.800	700	4	7
8	8	50	9.650	9.810	350	5	8
9	9	150	9.640	9.820	150	6	9
10	10	100	9.630				10
11				9.840	250	7	11
12				9.850	100	8	12
13							13
14				9.870	400	9	14
15				9.880	200	10	15
16				9.890	300	11	16

Highlights on Aggregate Order Book Management

Bid Side				Ask Side			
Tick	PriceLevel	AggregateQuantity	Price	Price	AggregateQuantity	PriceLevel	Tick
1	1	250	9.730	9.800	700	1	1
2	2	50	9.720	9.810	350	2	2
3	3	700	9.710	9.820	150	3	3
4	4	350	9.700				4
5	5	150	9.690	9.840	250	4	5
6	6	250	9.680	9.850	100	5	6
7	7	100	9.670				7
8	8	150	9.660	9.870	400	6	8
9	9	50	9.650	9.880	200	7	9
10	10	150	9.640	9.890	300	8	10
11	11	100	9.630				11
12							12
13							13
14							14
15							15
16							16

8th aggregate book order update entry

180	AggregateQuantity	100
188	Price	9850
192	NumberOfOrders	1
196	Side	1 (Offer)
198	PriceLevel	8
199	UpdateAction	2
200	Filler	NULL

Explicit Deletion

Bid Side				Ask Side			
Tick	PriceLevel	AggregateQuantity	Price	Price	AggregateQuantity	PriceLevel	Tick
1	1	50	9.720	9.740	450	1	1
2	2	300	9.710	9.750	550	2	2
3	3	350	9.700	9.760	650	3	3
4	4	150	9.690				4
5	5	250	9.680				5
6			9.670				6
7			9.660	9.800	700	4	7
8	8	50	9.650	9.810	350	5	8
9	9	150	9.640	9.820	150	6	9
10	10	100	9.630				10
11				9.840	250	7	11
12				9.850	100	8	12
13							13
14				9.870	400	9	14
15				9.880	200	10	15
16				9.890	300	11	16

Highlights on Aggregate Order Book Management

Bid Side				Ask Side			
Tick	PriceLevel	AggregateQuantity	Price	Price	AggregateQuantity	PriceLevel	Tick
1	1	250	9.730	9.800	700	1	1
2	2	50	9.720	9.810	350	2	2
3	3	700	9.710	9.820	150	3	3
4	4	350	9.700				4
5	5	150	9.690	9.840	250	4	5
6	6	250	9.680	9.850	100	5	6
7	7	100	9.670				7
8	8	150	9.660	9.870	400	6	8
9	9	50	9.650	9.880	200	7	9
10	10	150	9.640	9.890	300	8	10
11	11	100	9.630				11
12							12
13							13
14							14
15							15
16							16

9th aggregate book order update entry

204	AggregateQuantity	400
212	Price	9870
216	NumberOfOrders	1
220	Side	1 (Offer)
222	PriceLevel	9
223	UpdateAction	2
224	Filler	NULL

Bid Side				Ask Side			
Tick	PriceLevel	AggregateQuantity	Price	Price	AggregateQuantity	PriceLevel	Tick
1	1	50	9.720	9.740	450	1	1
2	2	300	9.710	9.750	550	2	2
3	3	350	9.700	9.760	650	3	3
4	4	150	9.690				4
5	5	250	9.680				5
6	6	100	9.670				6
7	7	150	9.660	9.800	700	4	7
8	8	50	9.650	9.810	350	5	8
9	9	150	9.640	9.820	150	6	9
10	10	100	9.630				10
11				9.840	250	7	11
12				9.850	100	8	12
13							13
14				9.870	400	9	14
15				9.880	200	10	15
16				9.890	300	11	16

Explicit Deletion

Highlights on Aggregate Order Book Management

Bid Side				Ask Side			
Tick	PriceLevel	AggregateQuantity	Price	Price	AggregateQuantity	PriceLevel	Tick
1	1	250	9.730	9.800	700	1	1
2	2	50	9.720	9.810	350	2	2
3	3	700	9.710	9.820	150	3	3
4	4	350	9.700				4
5	5	150	9.690	9.840	250	4	5
6	6	250	9.680	9.850	100	5	6
7	7	100	9.670				7
8	8	150	9.660	9.870	400	6	8
9	9	50	9.650	9.880	200	7	9
10	10	150	9.640	9.890	300	8	10
11	11	100	9.630				11
12							12
13							13
14							14
15							15
16							16

10th aggregate book order update entry

228	AggregateQuantity	200
236	Price	9880
240	NumberOfOrders	1
244	Side	1 (Offer)
246	PriceLevel	10
247	UpdateAction	2
248	Filler	NULL

Bid Side				Ask Side			
Tick	PriceLevel	AggregateQuantity	Price	Price	AggregateQuantity	PriceLevel	Tick
1	1	50	9.720	9.740	450	1	1
2	2	300	9.710	9.750	550	2	2
3	3	350	9.700	9.760	650	3	3
4	4	150	9.690				4
5	5	250	9.680				5
6	6	100	9.670				6
7	7	150	9.660	9.800	700	4	7
8	8		9.650	9.810	350	5	8
9	9		9.640	9.820	150	6	9
10	10		9.630				10
11				9.840	250	7	11
12				9.850	100	8	12
13							13
14				9.870	400	9	14
15				9.880	200	10	15
16				9.890	300	11	16

Explicit Deletion

Highlights on Aggregate Order Book Management

Bid Side				Ask Side			
Tick	PriceLevel	AggregateQuantity	Price	Price	AggregateQuantity	PriceLevel	Tick
1	1	250	9.730	9.800	700	1	1
2	2	50	9.720	9.810	350	2	2
3	3	700	9.710	9.820	150	3	3
4	4	350	9.700				4
5	5	150	9.690	9.840	250	4	5
6	6	250	9.680	9.850	100	5	6
7	7	100	9.670				7
8	8	150	9.660	9.870	400	6	8
9	9	50	9.650	9.880	200	7	9
10	10	150	9.640	9.890	300	8	10
11	11	100	9.630				11
12							12
13							13
14							14
15							15
16							16

Implicit Deletion

OMD sends explicit deletion for orders within 10 price level.

This order is of Price Level 11, clients have to perform implicit deletion to delete the entry so as to correctly maintain their book

Bid Side				Ask Side			
Tick	PriceLevel	AggregateQuantity	Price	Price	AggregateQuantity	PriceLevel	Tick
1	1	50	9.720	9.740	450	1	1
2	2	300	9.710	9.750	550	2	2
3	3	350	9.700	9.760	650	3	3
4	4	150	9.690				4
5	5	250	9.680				5
6	6	100	9.670				6
7	7	150	9.660	9.800	700	4	7
8	8	50	9.650	9.810	350	5	8
9	9	150	9.640	9.820	150	6	9
10	10	100	9.630				10
11				9.840	250	7	11
12				9.850	100	8	12
13							13
14				9.870	400	9	14
15				9.880	200	10	15
16				9.890	300	11	16

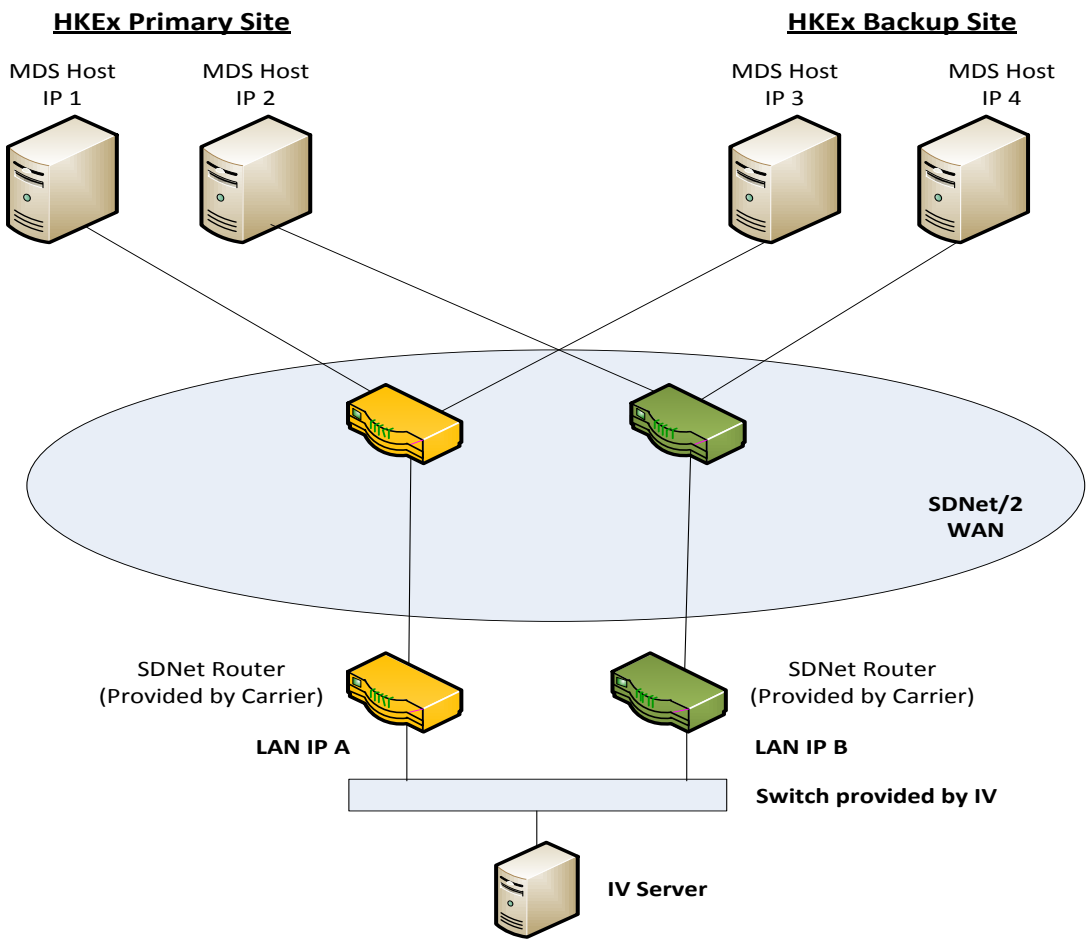
Highlights on Aggregate Order Book Management

- **Strictly follow the sequence in the book entry list of the *Aggregate Order Book Update (53)* to apply changes to 10BBO**
- **Apply implicit level adjustment to PriceLevels following addition/deletion of aggregate order book entry**
- **OMD sends explicit deletion/addition for book entries within 10 PriceLevel**
- **Clients perform implicit deletion for book entries beyond 10 PriceLevel**
- **Techniques used in aggregate order book management:**
  - **Explicit Deletion/Addition**
  - **Quantity Reduction**
  - **Implicit Deletion**
  - **Implicit Level Adjustment**

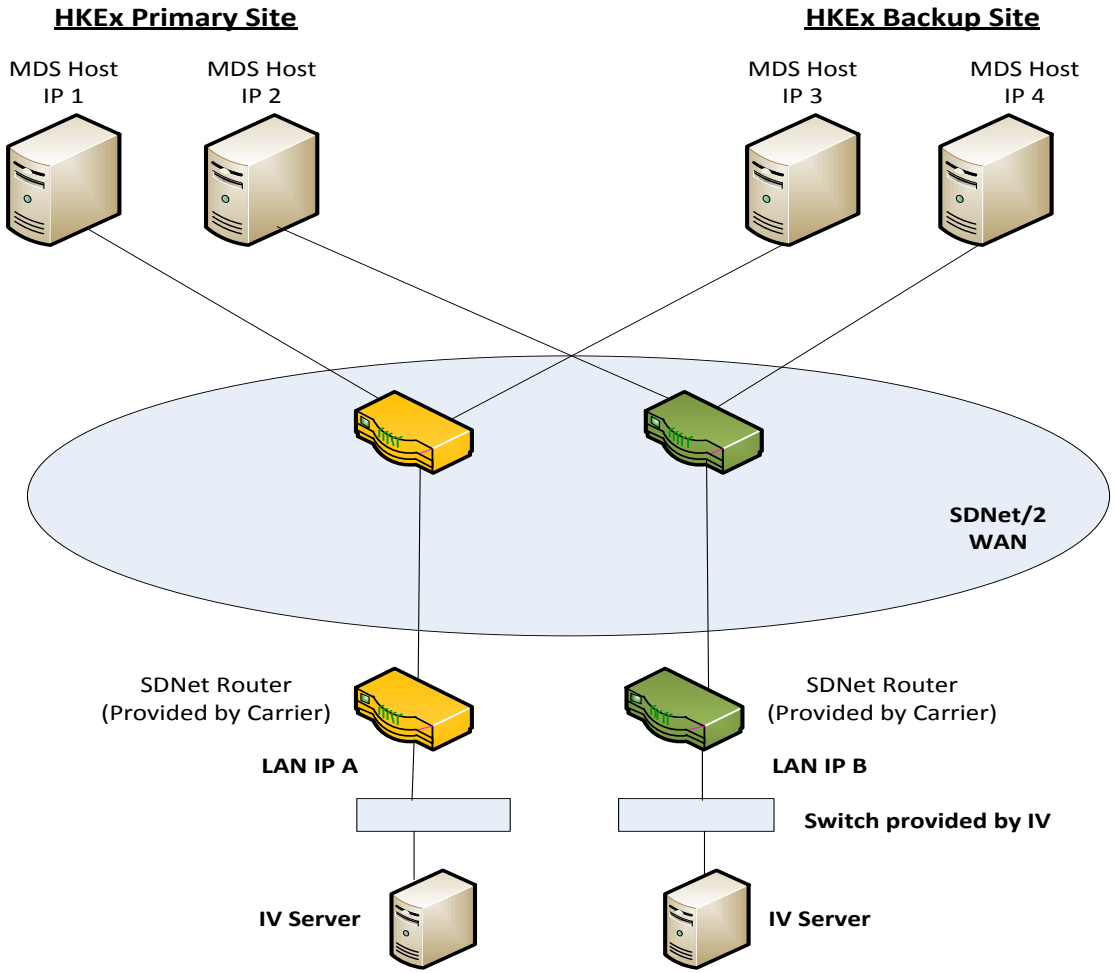
AGENDA – Part 3

1. Existing MDS Network
2. Network for OMD

Existing MDS Network



Existing MDS Network



Existing MDS Network

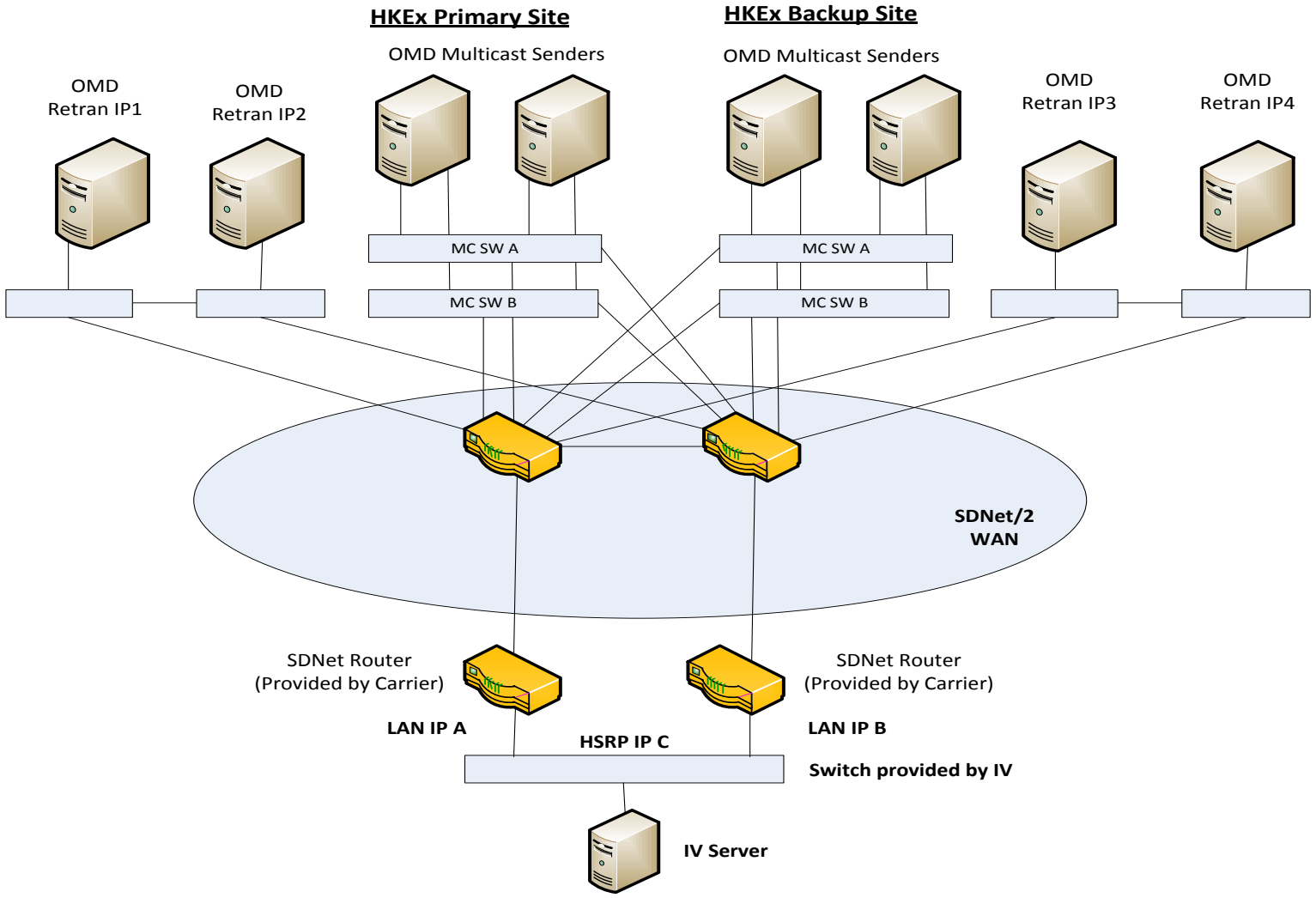
- Two separate networks for two links
- Unicast only
- No network failover mechanism built-in, application need to detect TCP session disconnection and call to another host IP.

AGENDA – Part 3

1 Existing MDS Network

2 **Network for OMD**

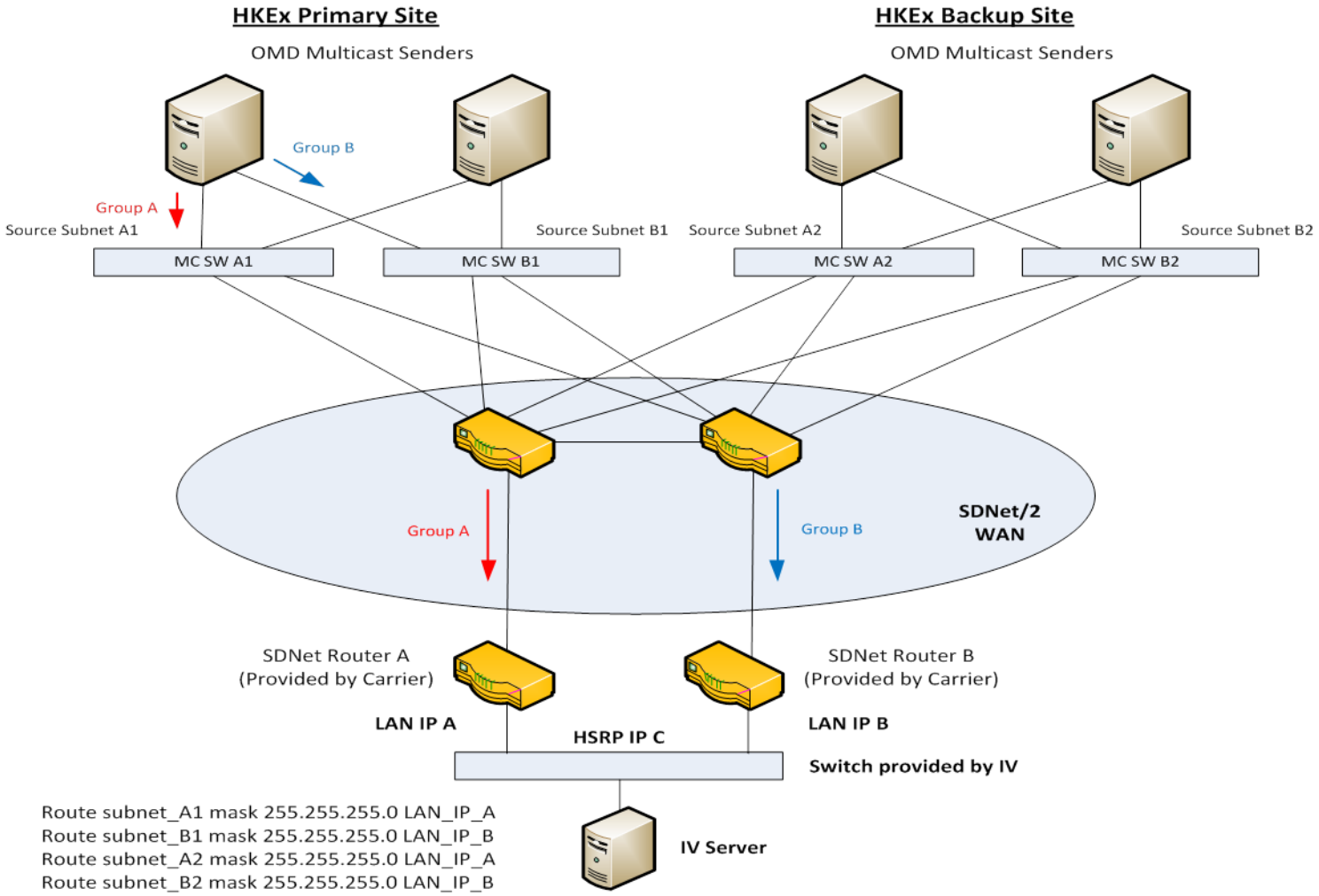
Network for OMD



Network for OMD

- Support both Unicast and Multicast Traffic
- Separate bandwidth for Multicast and Unicast Traffic
- With network failover mechanism built-in
- Two circuits are required to install in a single site
- New subnet for OMD at IV end will be provided

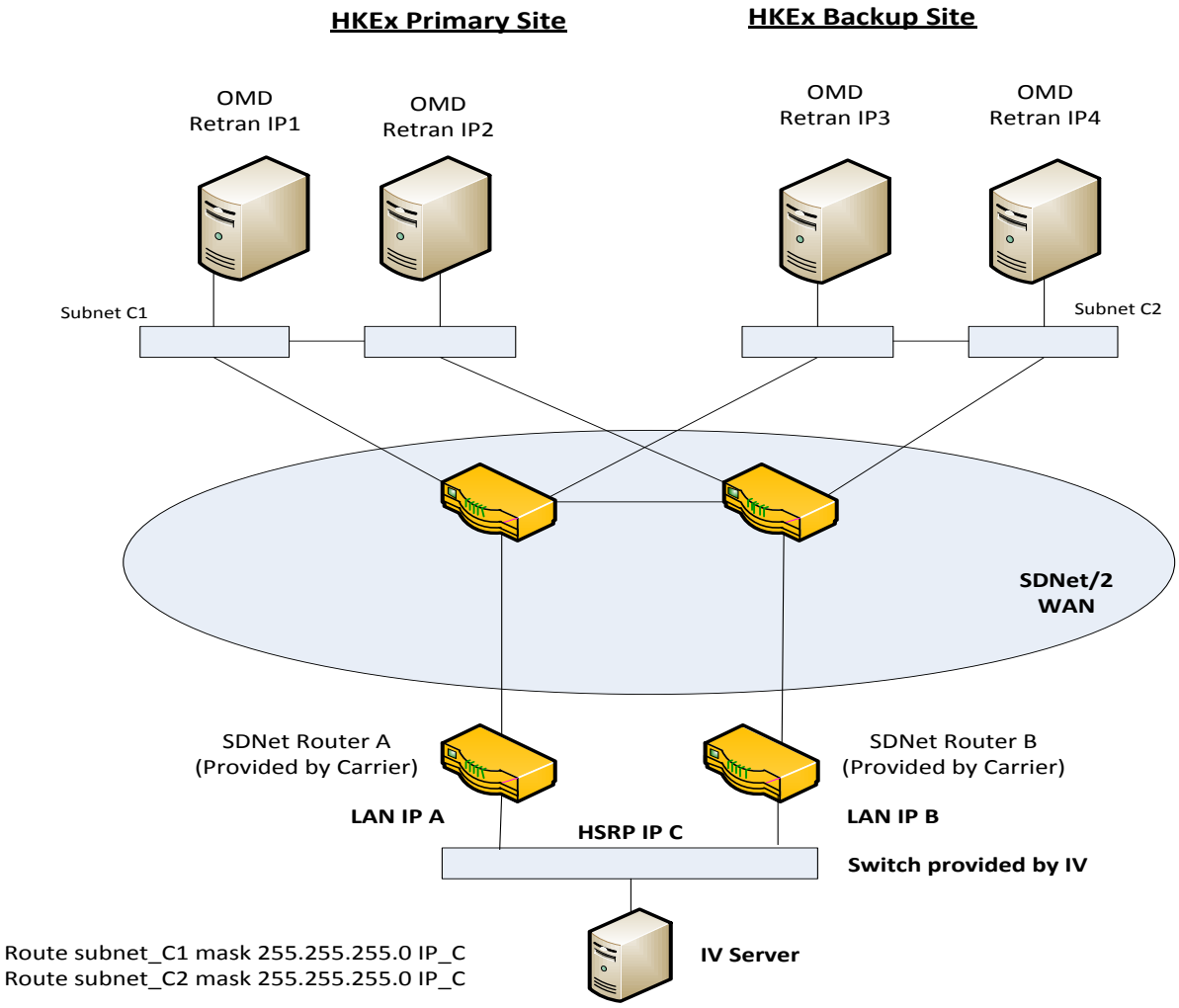
Network for OMD - Multicast



Network for OMD – Multicast

- Multicast Traffic is sent in pair of multicast group IPs (A & B)
  - Eg. (239.0.1.1 and 239.0.127.1)
  - A&B carries same information with different destination address (group address)
- Different paths for two multicast streams:
  - A: via router A; B: via router B
- IV applications need to join both A&B multicast groups with IGMP version 2
- IV applications will receive both A&B multicast traffic under normal condition. If one router or one link fails, there will be only one (either A or B) will be received
- Multicast will check reverse path, therefore, IV servers need to add route for the IP multicast sources

Network for OMD - Unicast



Network for OMD – SDNet/2

- **To support OMD, SDNet/2 comes with a High Performance Option, where the circuits can support high data throughput for bandwidth >= 30Mbps**

Bandwidth	PCCW (<= HKD)	HGC (<= HKD)	WTT (<= HKD)
30M	10,560	N/A	6,410
40M	12,540	N/A	7,310
50M	14,520	N/A	8,210
60M	16,350	N/A	8,440
70M	18,150	N/A	8,970
80M	19,950	N/A	9,500
90M	21,900	N/A	10,030
100M	23,700	N/A	10,560
1G	63,300	N/A	15,560

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THANK YOU