



WOMBAT
FINANCIAL SOFTWARE

Wombat Data Fabric: Bringing the Power of Native IB To Financial Services... *(and beyond?)*

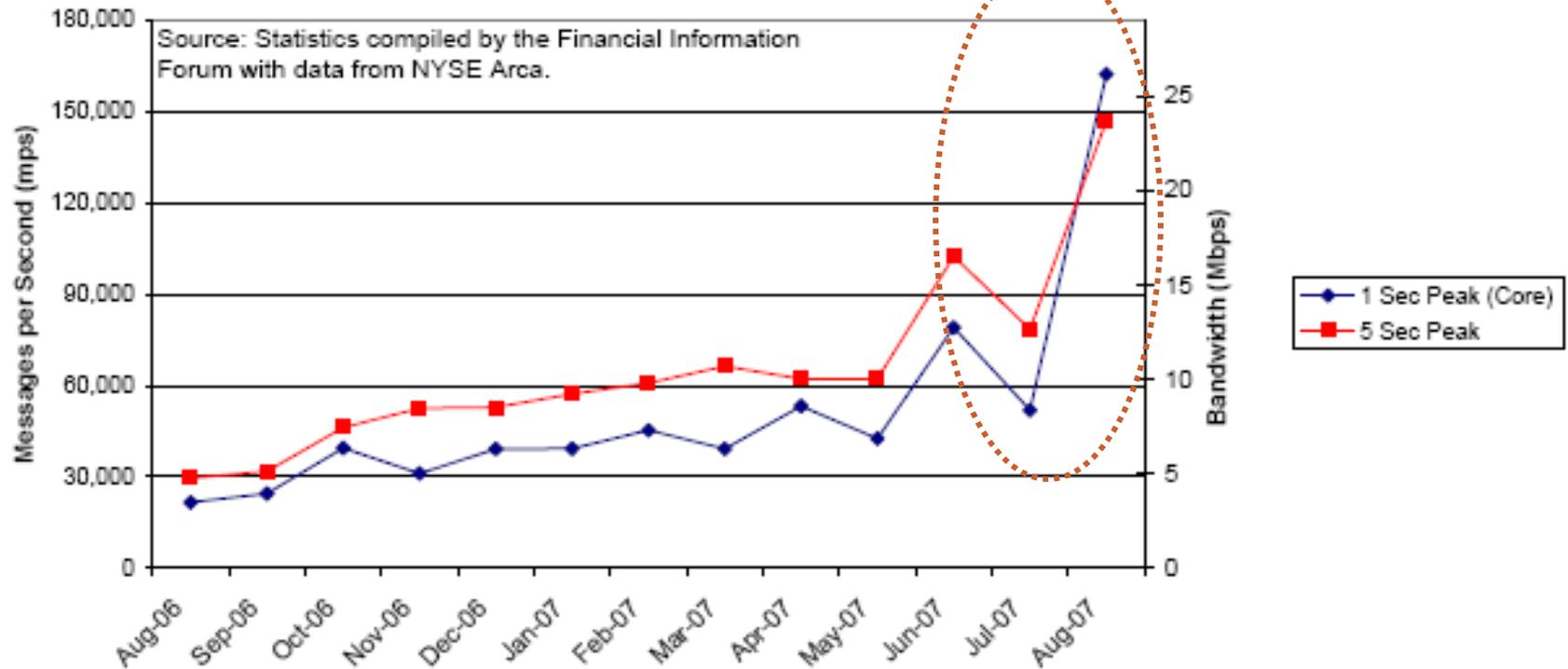
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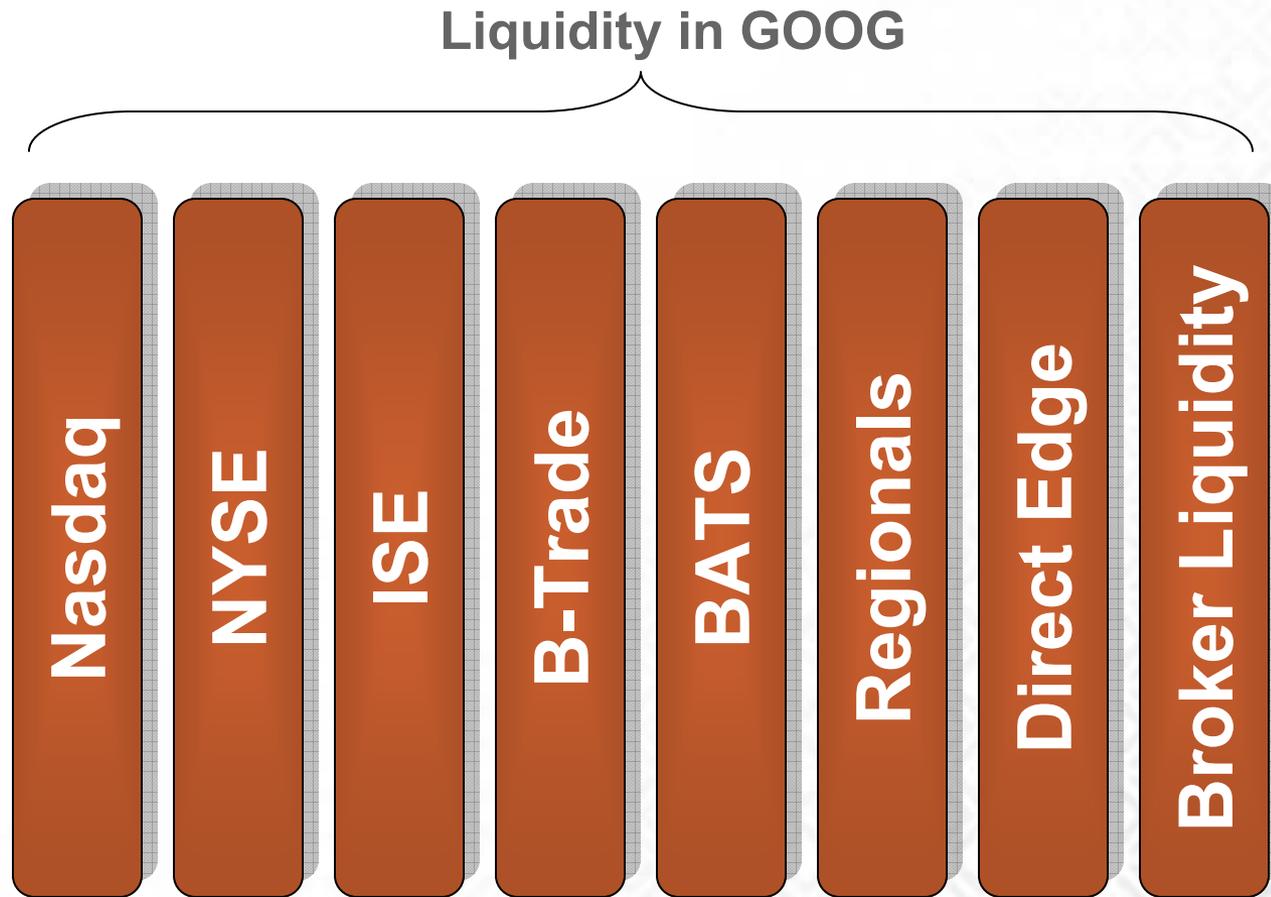
Shameless Chest Thumping

- › **Experts in high performance connectivity**
- › **Focused on the “Algorithmic Trading” Market**
- › **“Twice as fast” – Jerome Downey, MD Bear Stearns, WS&T magazine**
- › **All of the top 13 banks are customers (US, Europe, Asia)**
- › **2 to 3X revenue growth YoY last 3 years**

Innovation Driving Spikes

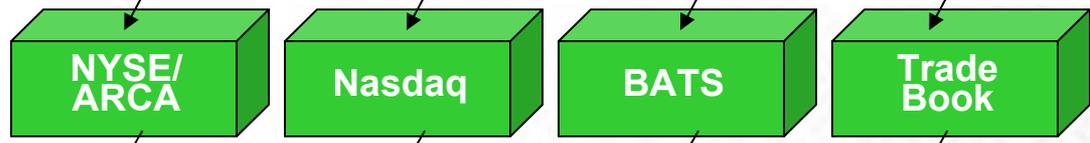


A Compounded Problem



SuperBook-
Generates
Insights...and
MORE data still

All Liquidity in NASDAQ: GOOG



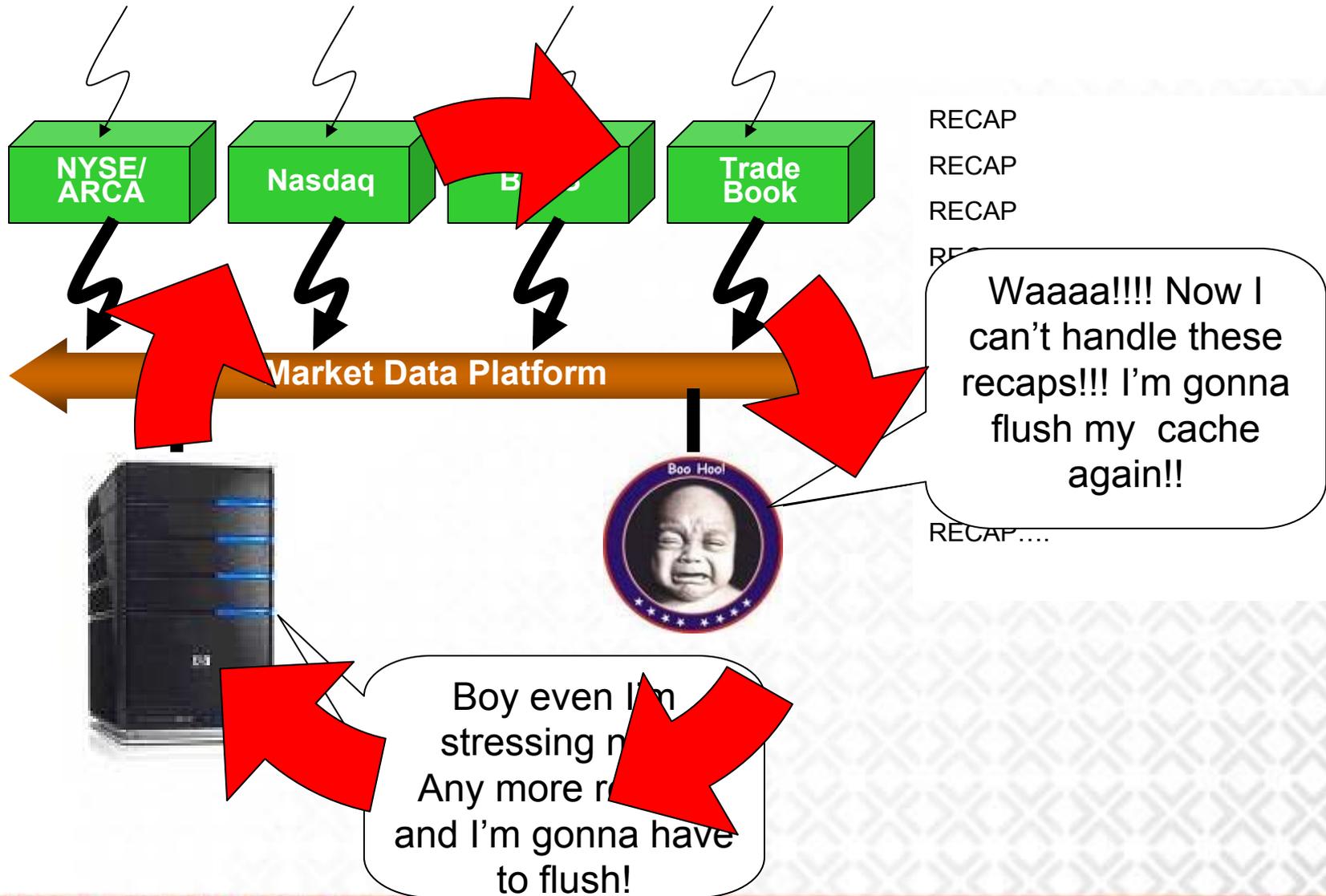
SuperBook

MAMA					
MKT	B-Size	BID	ASK	A-Size	MKT
BATS	500	20.05	20.07	2000	BTRD
ARCA	1000	20.04	20.07	400	NASD
ARCA	200	20.04	20.08	1000	BATS
NASD	2000	20.03	20.10	500	BATS
BATS	400	20.01	20.12	1000	BTRD
BTRD	1000	19.98	20.12	200	ARCA
...

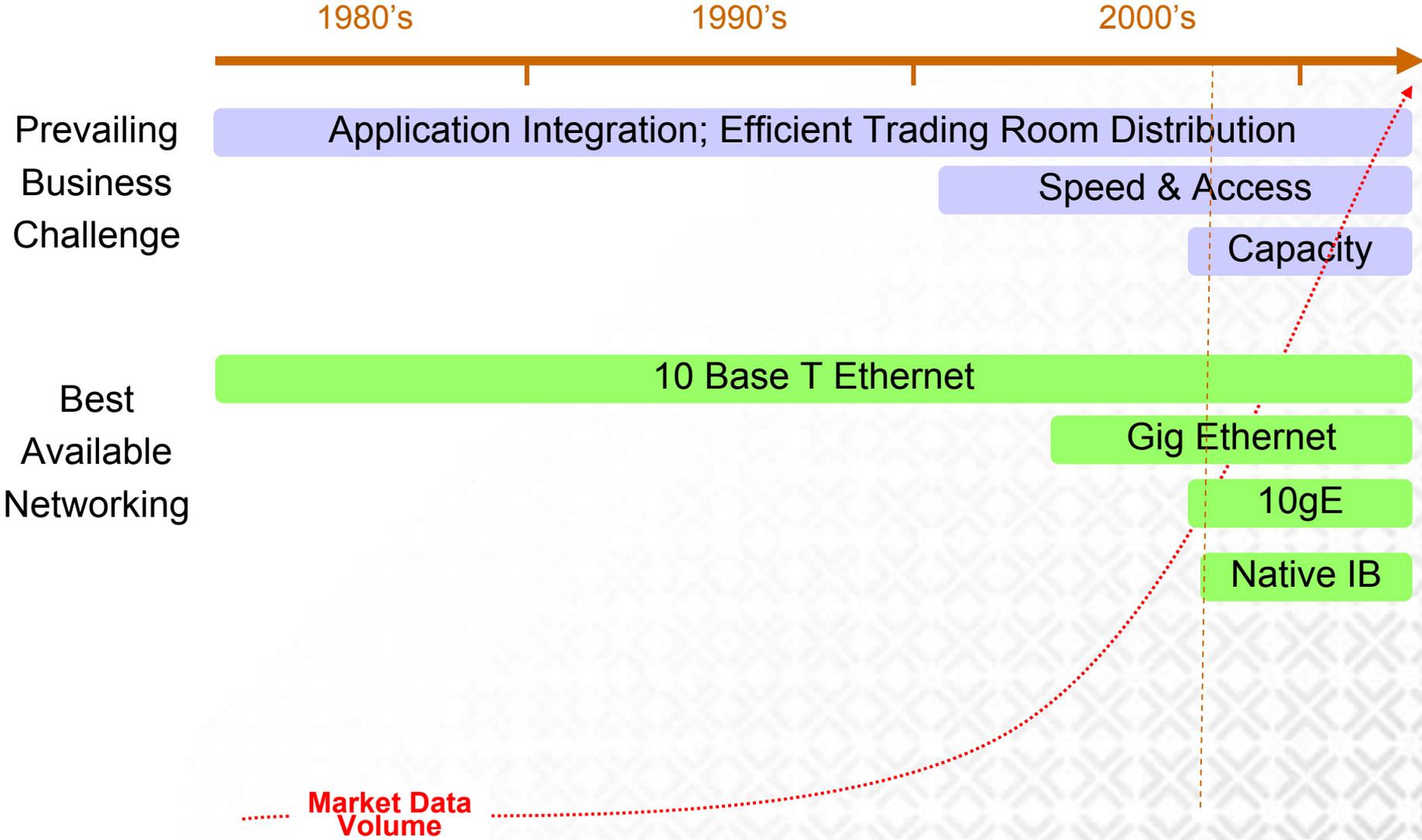
Net Effect: Server Sprawl

- › **Hardware**
- › **Rack Space**
- › **Power**
- › **Cooling**
- › **Management**

Retransmissions and the Crybaby Consumer



Market Data Middleware Evolution



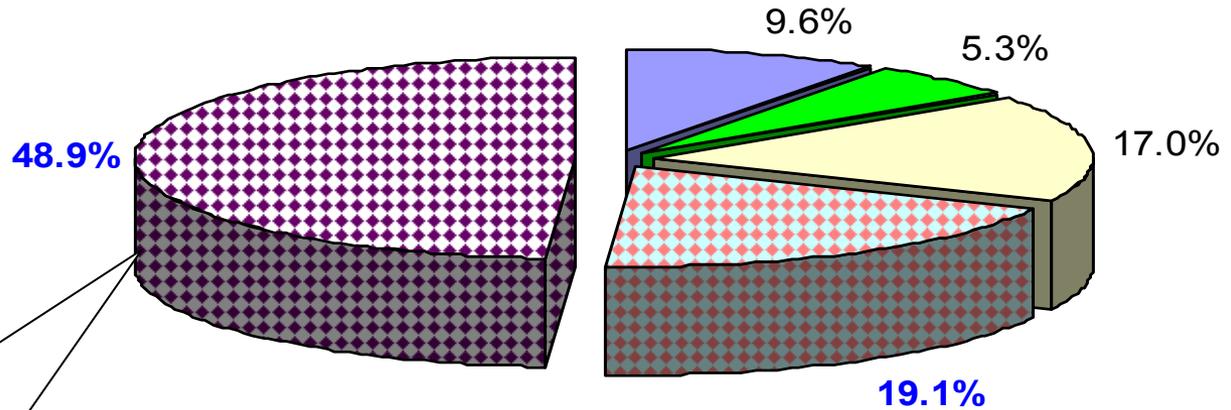
Wombat Middleware Innovation: Addressing Market Data Business Issues

Design Goals

- › **Deliver world class performance**
(*reliable speed*)
- › **Minimize sprawl**
- › **Enable business agility**

Compute Consumption: The Problem's in the I/O

Feed Handler Component CPU Consumption



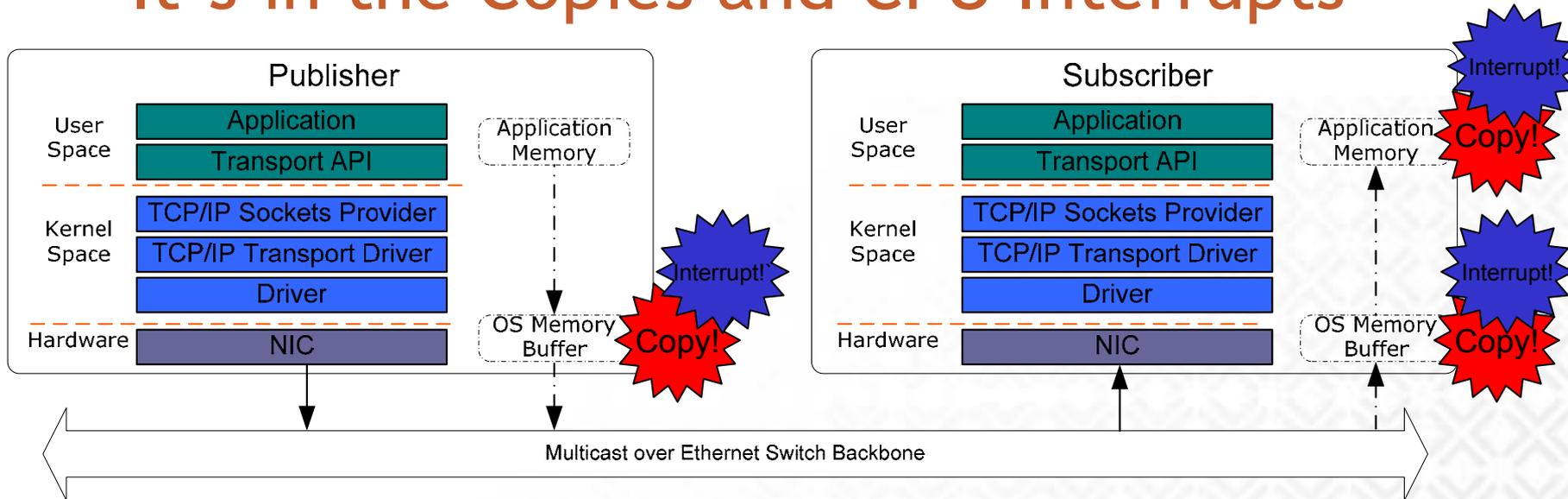
Offload-able from CPU!

- > General I/O
- > Unnecessary QoS code
- > Multicast channel overkill

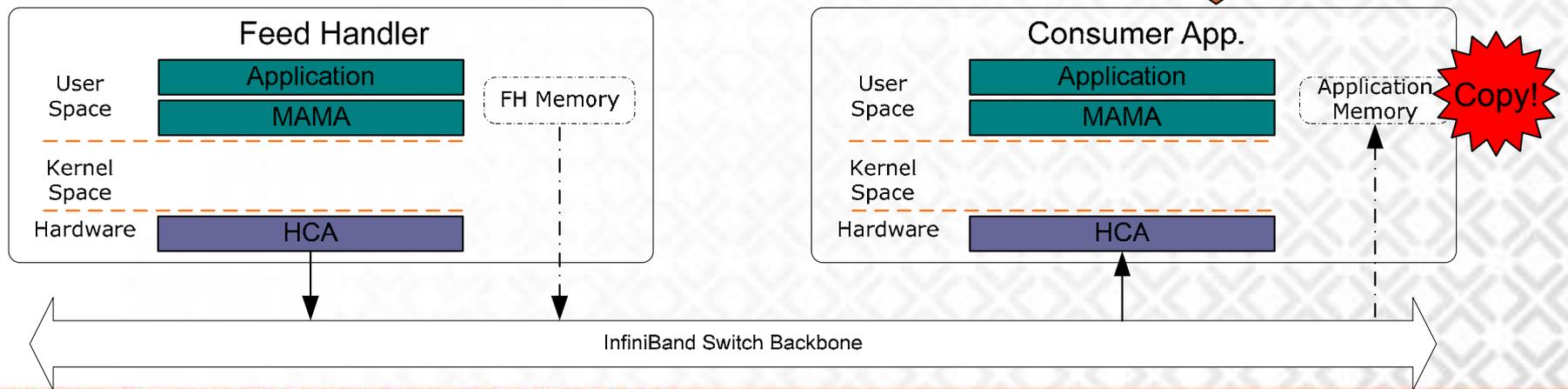
■ Line Handler ■ Message Handler □ Record Handler
■ Publisher ■ Middleware

Latency Induction:

It's in the Copies and CPU Interrupts



↑ Ethernet Delivery vs RDMA over InfiniBand ↓



Wombat's IB Journey

IP over IB

- › Plain Ethernet over IB hardware
- › Minimal change
- › Modest performance gains

SDP, MCE, DAL

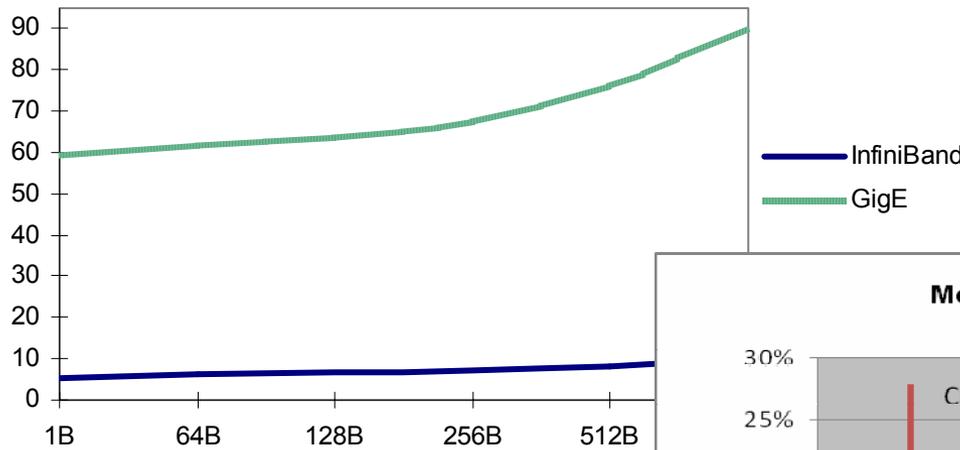
- › Ethernet over IB *with kernel bypass*
- › Leverage multicast offload for better efficiency
- › Meaningful performance gains

Native InfiniBand

- › IB now the transport
- › Optimal CPU and network utilization
- › From Pub Sub to Reads
- › Innovation frontier opened

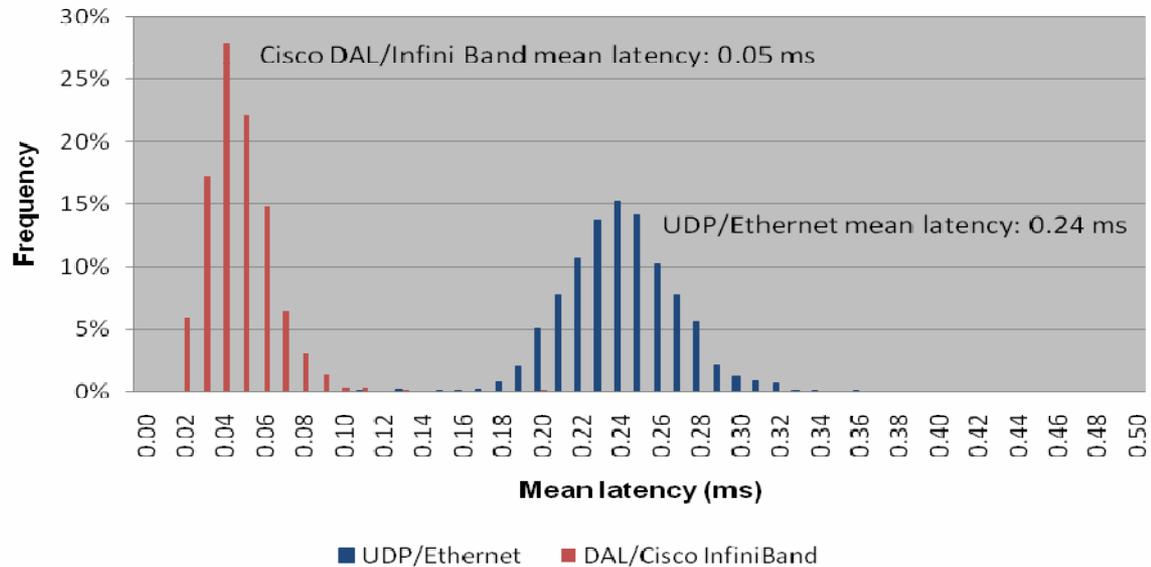
InfiniBand: Fast, Guaranteed Delivery

Comparative Latency in Nanoseconds



Source: NCSA

Mean latency histogram - all observations for all runs
4x Recorded Rate



Source: STACresearch.com

Wombat Data Fabric: The Market Data over RDMA Solution

- › World's only Native IB/RDMA Middleware
- › From publish to reads
- › Throughput: 1 million messages/sec and beyond...
- › Reduced CPU/Bandwidth consumption
 - › Minimal CPU interrupts
 - › Zero copies
 - › I/O offload to the HCA
- › No retransmissions / crybabies
- › Commodity x86 servers; the flexibility of software
- › New horizons for innovation

Just One 8-core 1U Server...



Can Deliver more than
500,000 messages/sec
Under 100u-secs

Sockets vs Shared Memory

Sockets - Ethernet

- › **Transient messages**
- › **Retransmission handling**
- › **Heavy context switching in the OS**
- › **Multiple copies in the I/O stack**
- › **1 GB per sec**
- › **Latency ~0.5ms**
- › **Latency jitter (long tails)**
- › **Saturation 625,000 messages per sec**
- › **Streaming data required to maintain state**

Shared Memory - Infiniband

- › **Data persisted in shared memory**
- › **Consume at will**
- › **OS bypass**
- › **“Zero copy”**
- › **20-40 Gb per sec**
- › **Latency ~0.065ms**
- › **Tight latency distribution**
- › **Saturation 10,000,000 per sec (per port)**
- › **Zero latency snapshot**
- › **Tick series in the fabric**

Enterprise-Wide Enablement

Plug in >100 Wombat Feed Handlers

Choose from a range of off the shelf apps from Wombat and third parties

Direct Exchange / ECN / Broker Data Feeds

Aggregated Vendor Data Feeds

Feed Handlers

Value Added Servers

- SuperBook
- Wombat Acumen
- Third Party Apps

Wombat Data Fabric

Ultra Low Latency Applications

Local Trading Networks

Cascading Cache

Wide Area Network Caching & Distribution Servers

Cascading Cache

Multicast over LBM, RV... or TCP over Wombat Middleware

WAN Links / Internet

Remote Branches and Customers

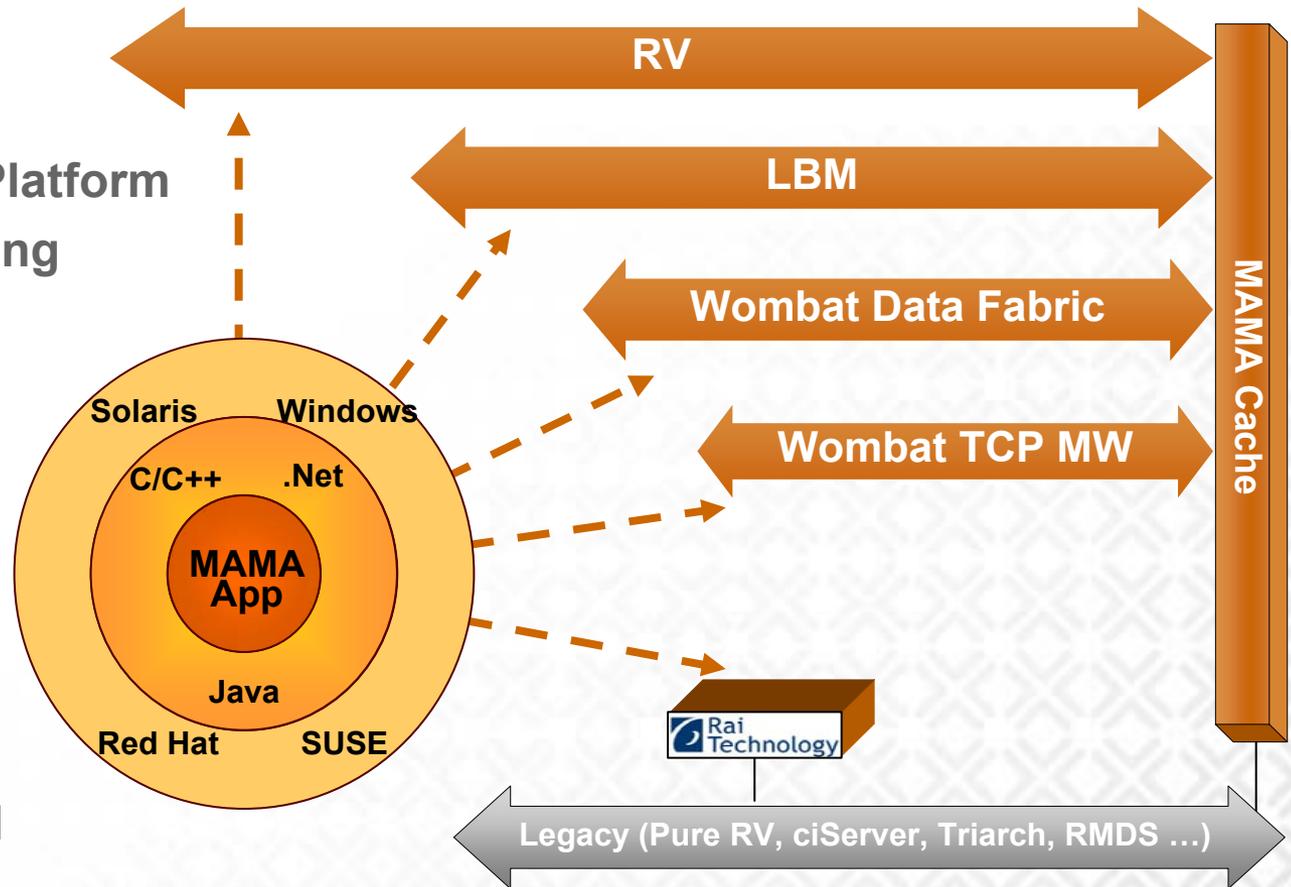
Cascading Cache

Multicast over LBM, RV... or TCP over Wombat Middleware

Interoperate with Ethernet middlewares via caches to meet varying needs and constraints across the enterprise

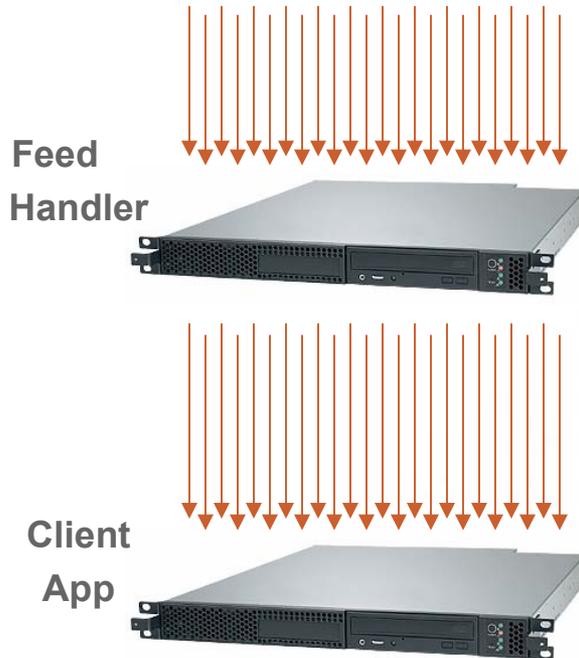
Unification via MAMA 4.0

- › Binds the Wombat Platform & abstracts underlying middleware
- › Low overhead
- › Multi Impl.
- › Dynamically loadable
- › Standard programming model



Future Innovations: Market Data Object RDMA

Order Books with Traditional Middleware



Book state must be maintained
in subscriber

Order Books with Data Fabric



Book state maintained in feed
handler & requested on
demand in "zero" latency

Future Innovations: Local DMA with MAMA

- › Port apps from remote machines to inside the publisher
- › No recoding needed: still MAMA

RDMA



“LDMA”



In Summary

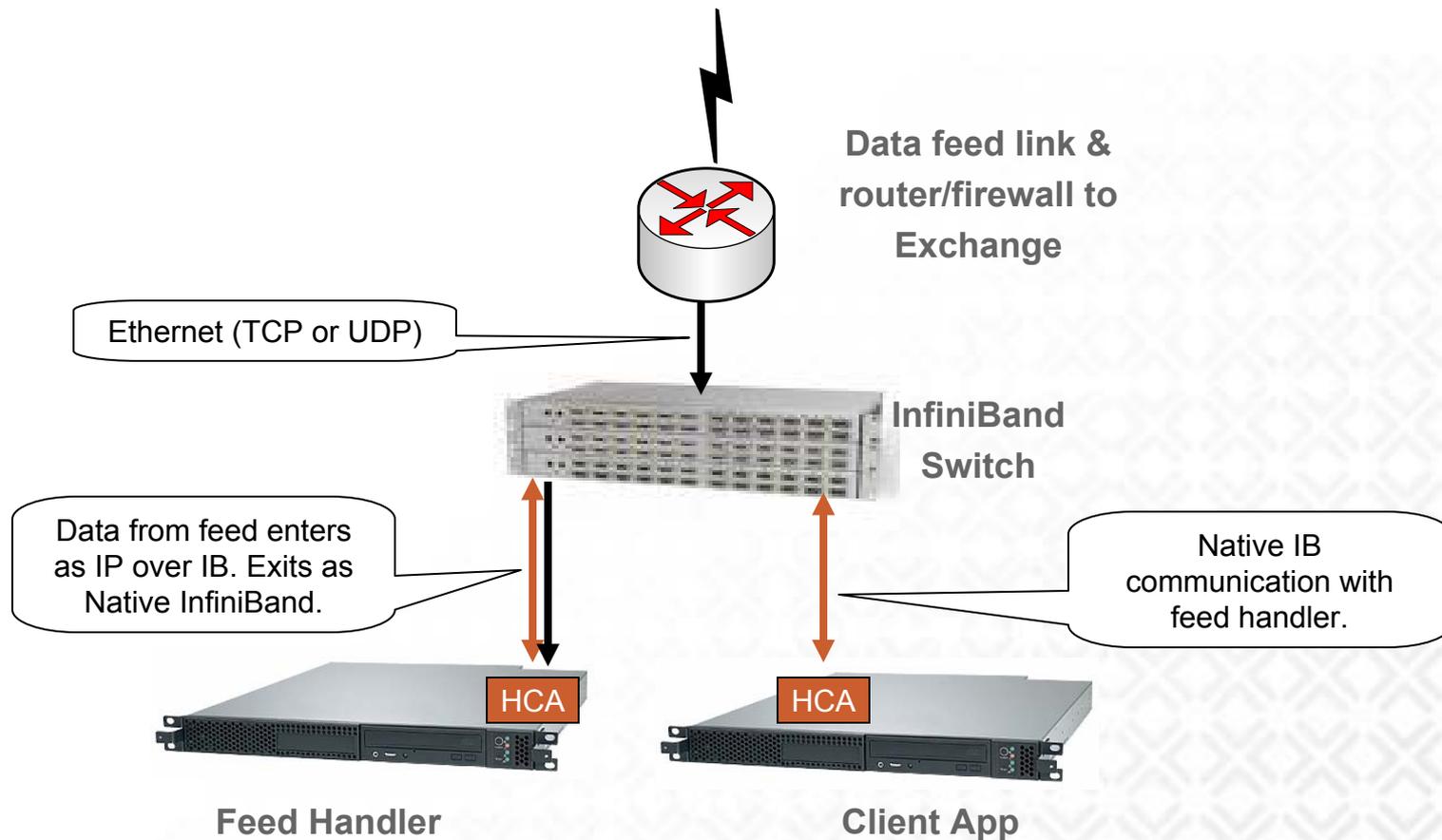
- › **IB is crossing the capital markets chasm now**
- › **Wombat Data Fabric wraps the benefits of IB & RDMA under a pub sub-like middleware**
- › **Now Alpha. Launch Dec 2007 in capital markets**
- › **Looking for opportunities to add value beyond...**

Supporting Materials

FPGA?

- › **A single node solution- not a platform solution**
 - › **The handler may be faster- but what about your apps?**
- › **Possible value but less than WDF provides**
- › **VHDL programming- DANGER**
 - › **How to handle exchange data changes?**
 - › **C to VHDL tools are not proven to be mature**
- › **Not supported by enterprise server community yet**
- › **Yet still under Wombat exploration**

Simple Physical Architecture



Rendezvous Hops

