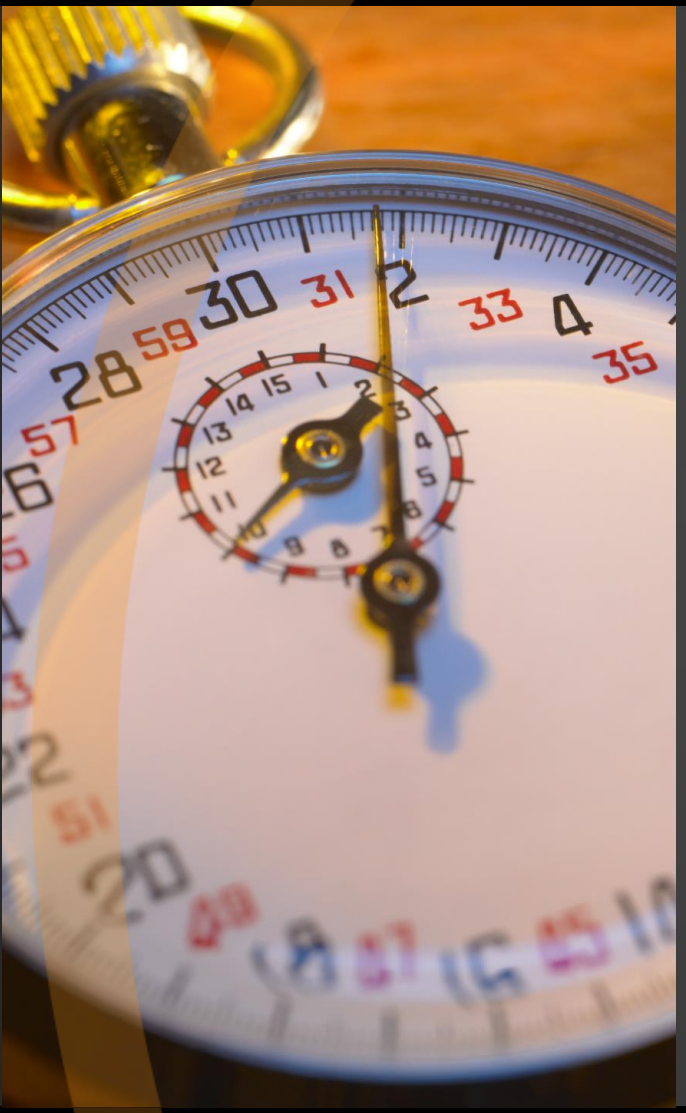
Design Patterns for Large Scale Data Movement

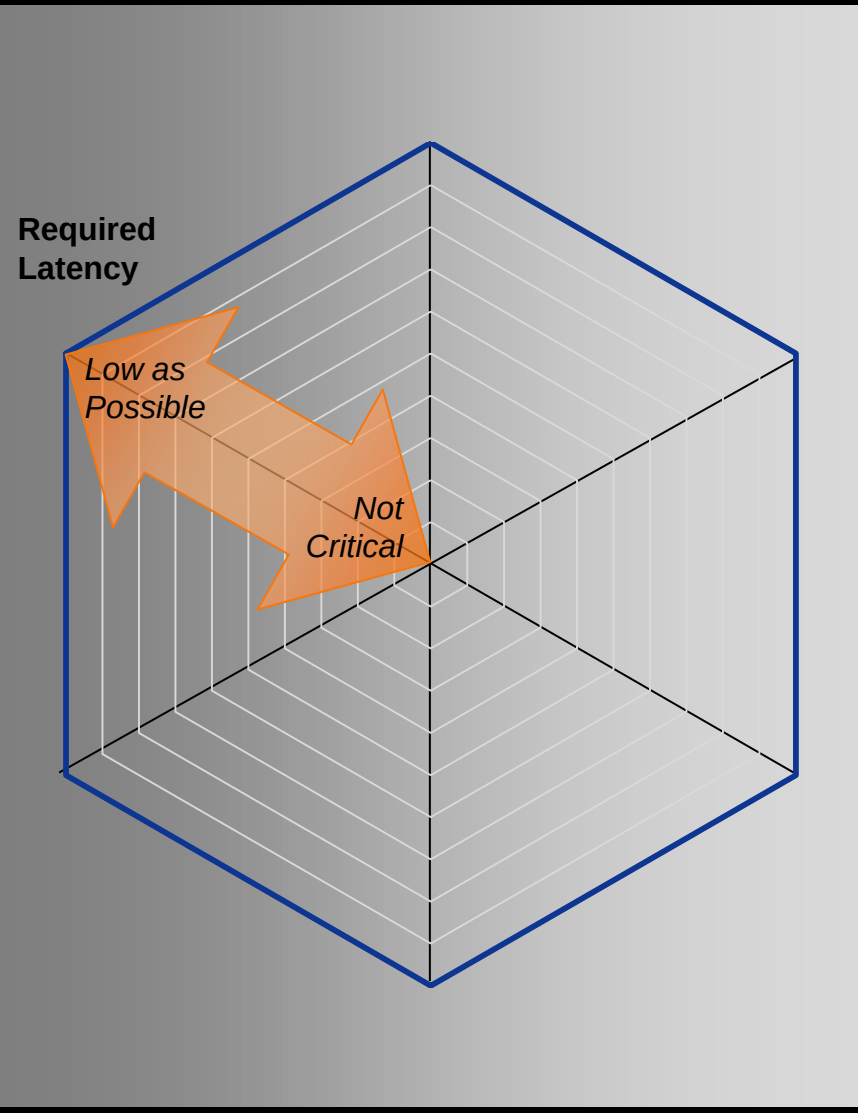
Data Movement Patterns

- **The right solution depends on the problem you're solving**
  - Real-time or intermittent?
  - Any weird networks?
  - Acceptable latency?
  - Humans or machines?
  - Update rates?
  - Fan-in or fan-out?
  - Payload size?
  - Guarantee required?

Latency Required

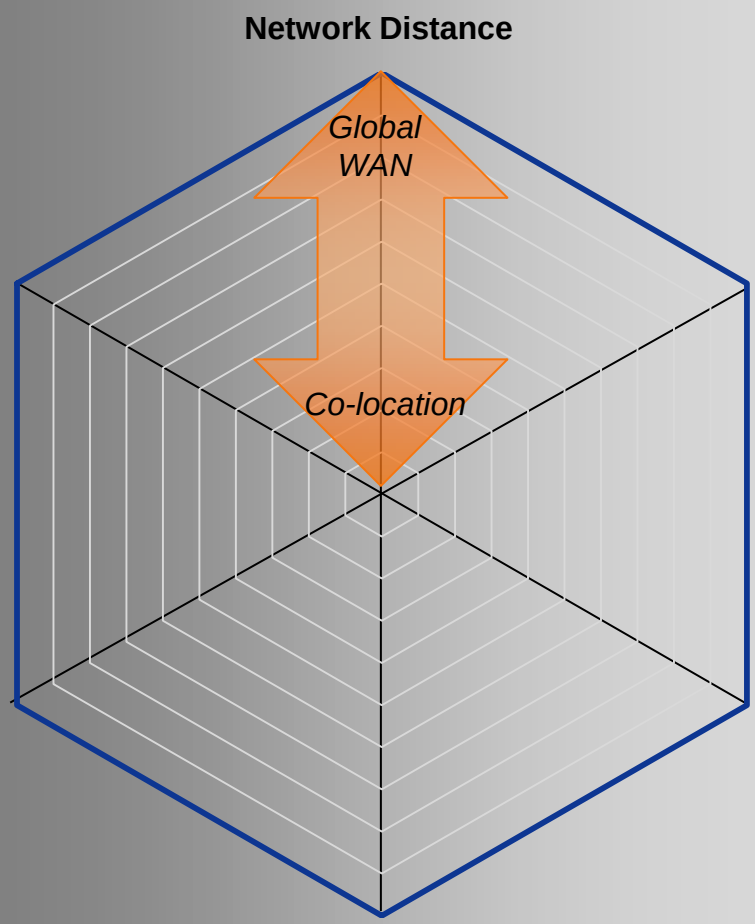


- Some not sensitive at all
  - Batch updates
- Seconds often good enough
  - Database sync
  - User interfaces
- Others measure in milli- or micro-seconds
  - Algo trading
  - Industrial controls



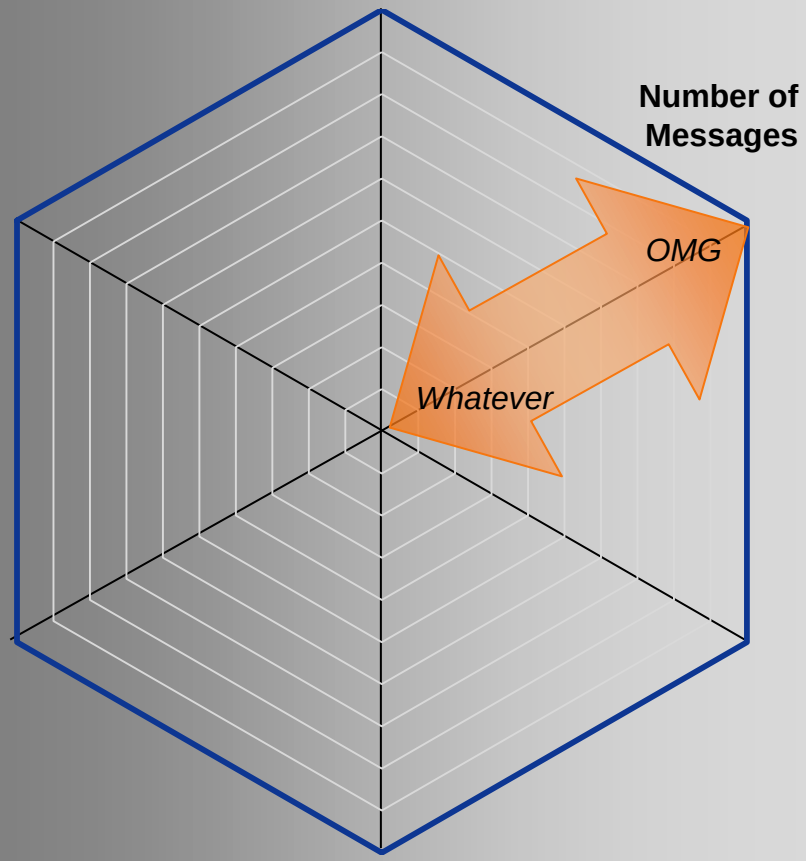
Network Distance

- **Co-location for max speed**
  - Minimize speed of light
- LAN for many apps
  - 10GigE networks
- Long distance WAN
  - Expensive, limited pipes
  - Creates mismatches with other networks



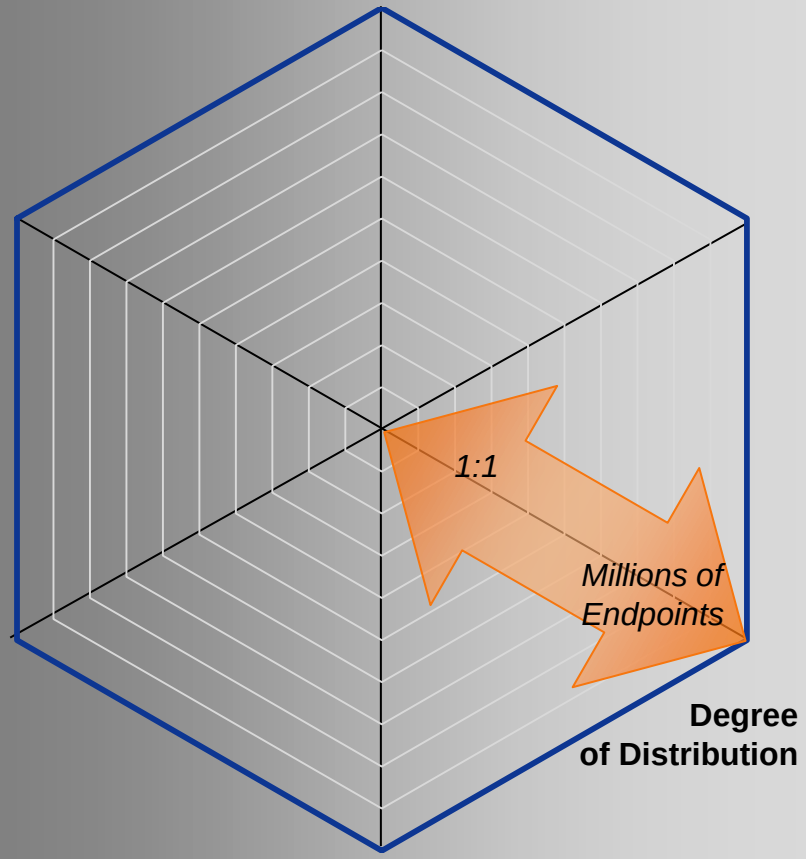
Number of Messages

- Few
  - Batch updates
  - Simple applications
- Moderate
  - Risk management
  - Order routing
- Insane
  - Market data
  - Click stream analysis



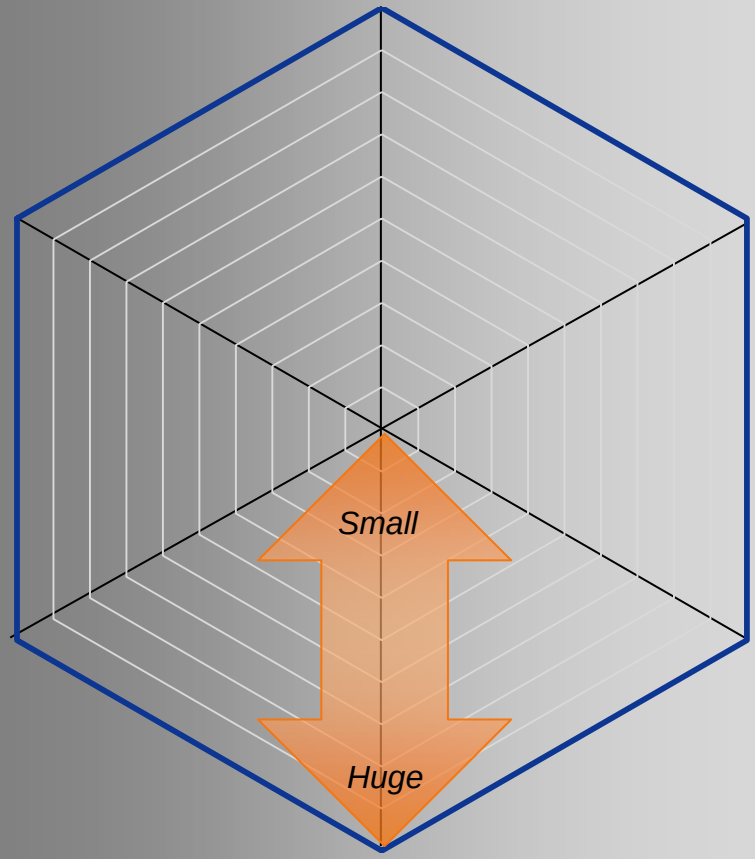
Degree of Distribution

- Point-to-point
- Fan-out (many subs)
- Fan-in (many pubs)
- Mesh
  - Synching data between many endpoints



Message Size

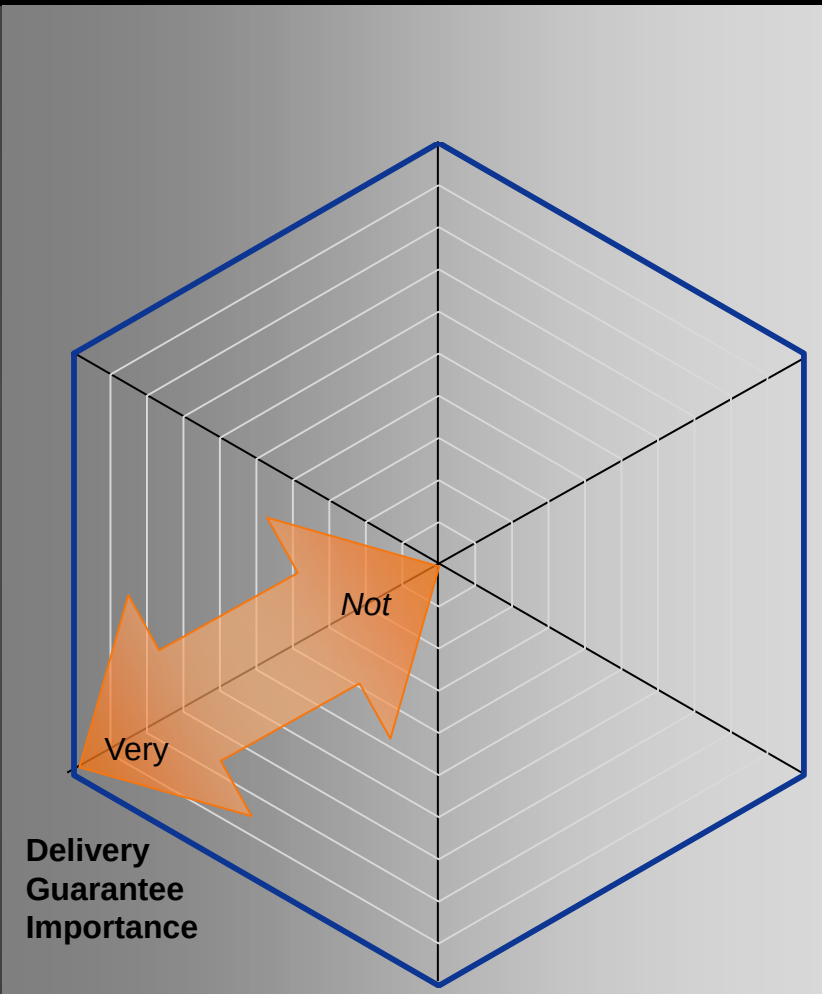
- Small
  - Status updates, activity logging events
- Medium
  - Orders, product BOMs
- Large
  - Batch updates, media files, product catalogs
- Very different stresses on system based on message size and frequency.



Size of Messages

Importance of Delivery Guarantee

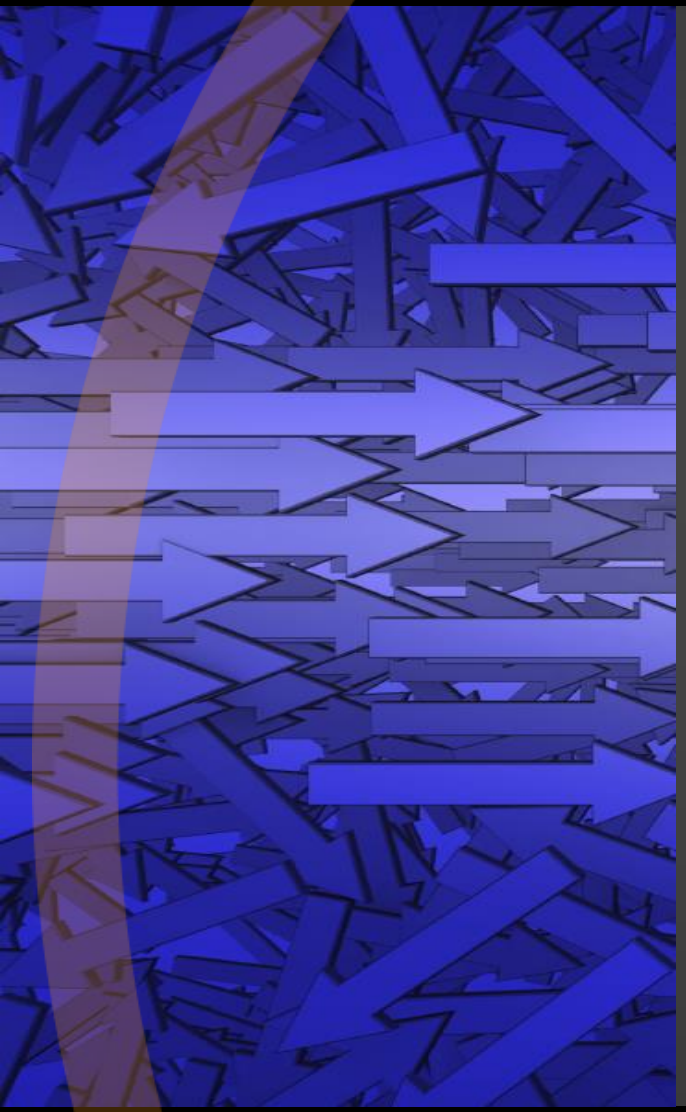
- “Best effort” fine for some scenarios
- Others require “once and only once”
- Sequence matters for some
- Some demand failsafe even in DR scenarios



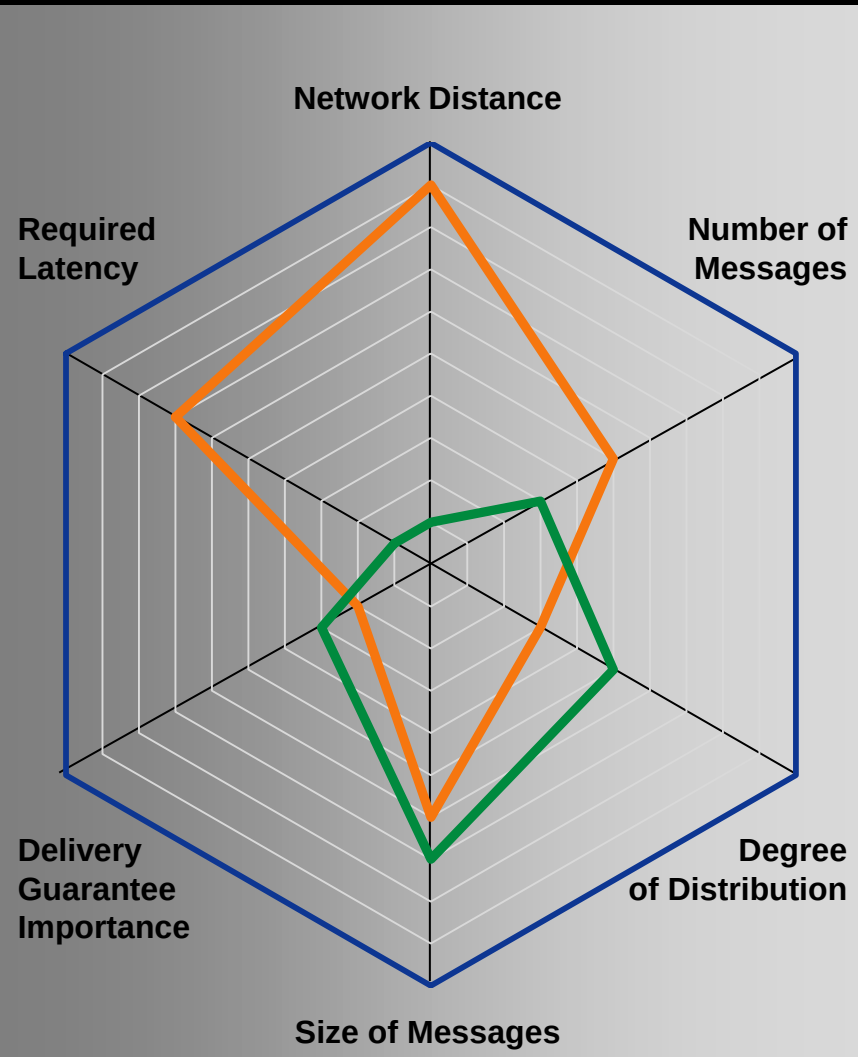
Other Considerations

- Message
  - Format
  - Protocol
  - Structured/Unstructured
- Network
  - Availability
  - RTT
  - Bandwidth cost
- Robustness
  - Archival
  - Caching
  - Acceptable MTBF
  - HA switchover times
  - DR requirements

Combination of Factors Yields Design Patterns



- Some attributes tend to correlate
  - # of messages and degree of distribution
- Others usually contradict
  - Network distance and latency
  - Guarantee and latency
- Tradeoffs and creative solutions



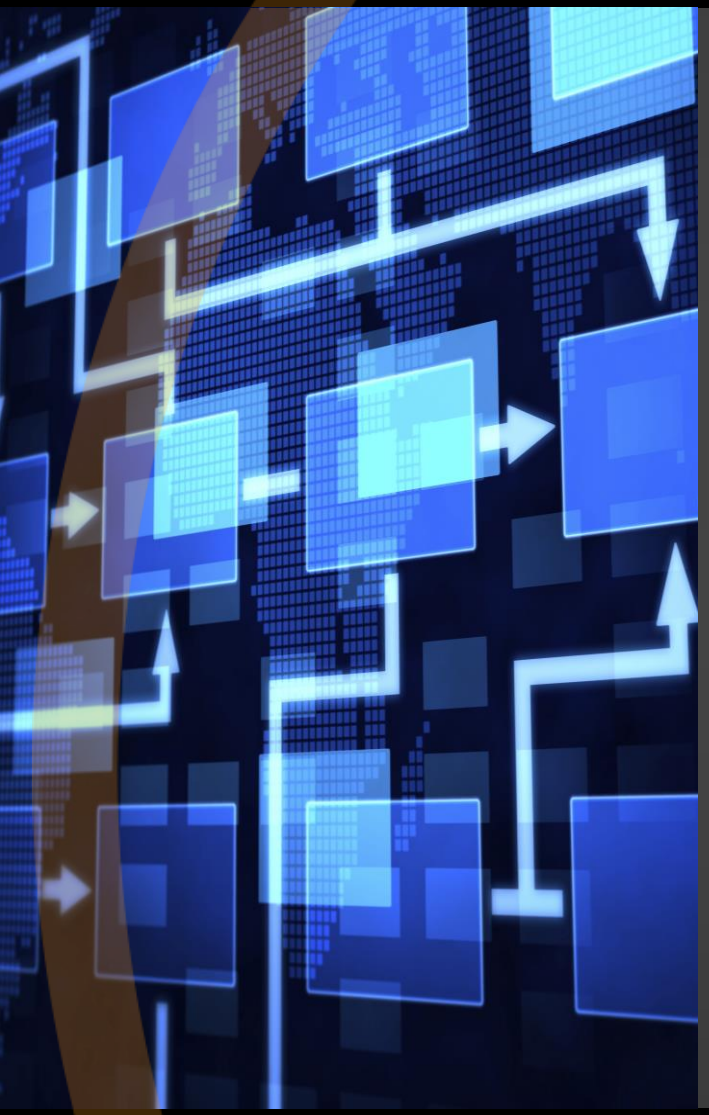
Identifying Patterns in Real-World Use Cases

Use cases unique,
but patterns emerge

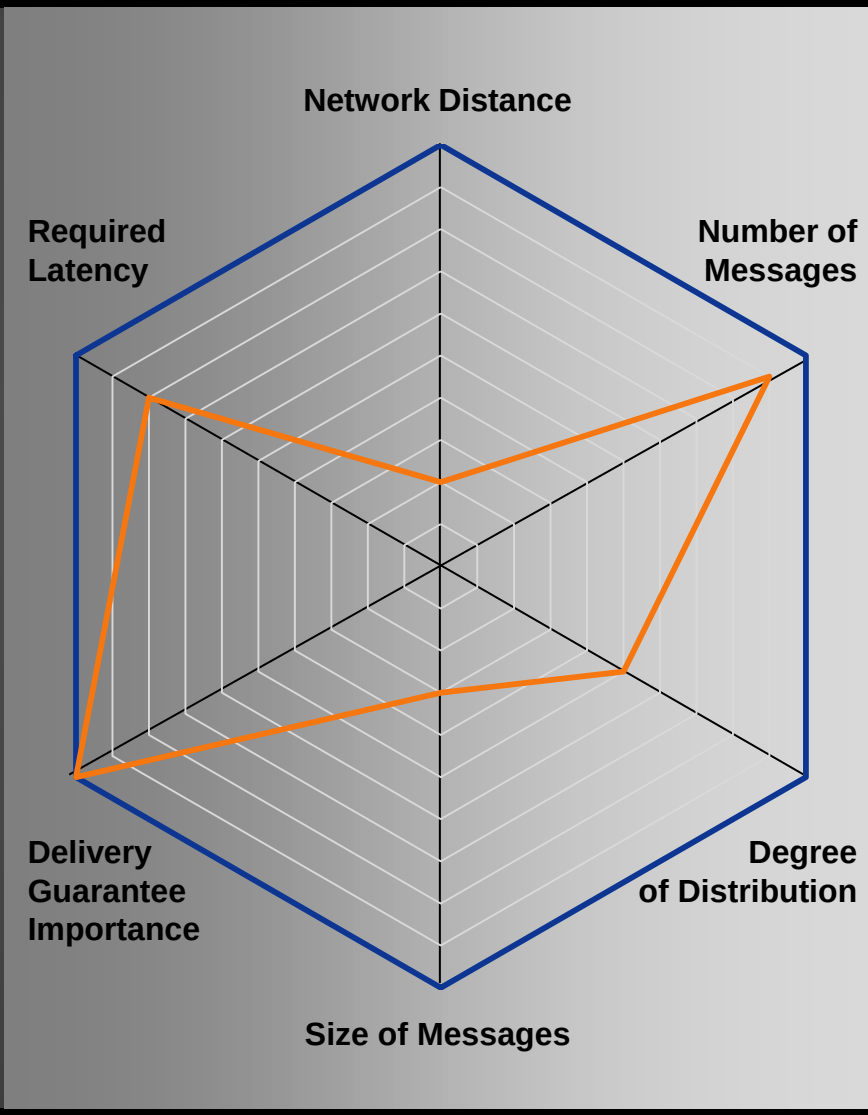
Examples in this section:

- Trade Order Flow
- Manufacturing Data Sync
- Oil and Gas Monitoring
- Real Time Sports Betting

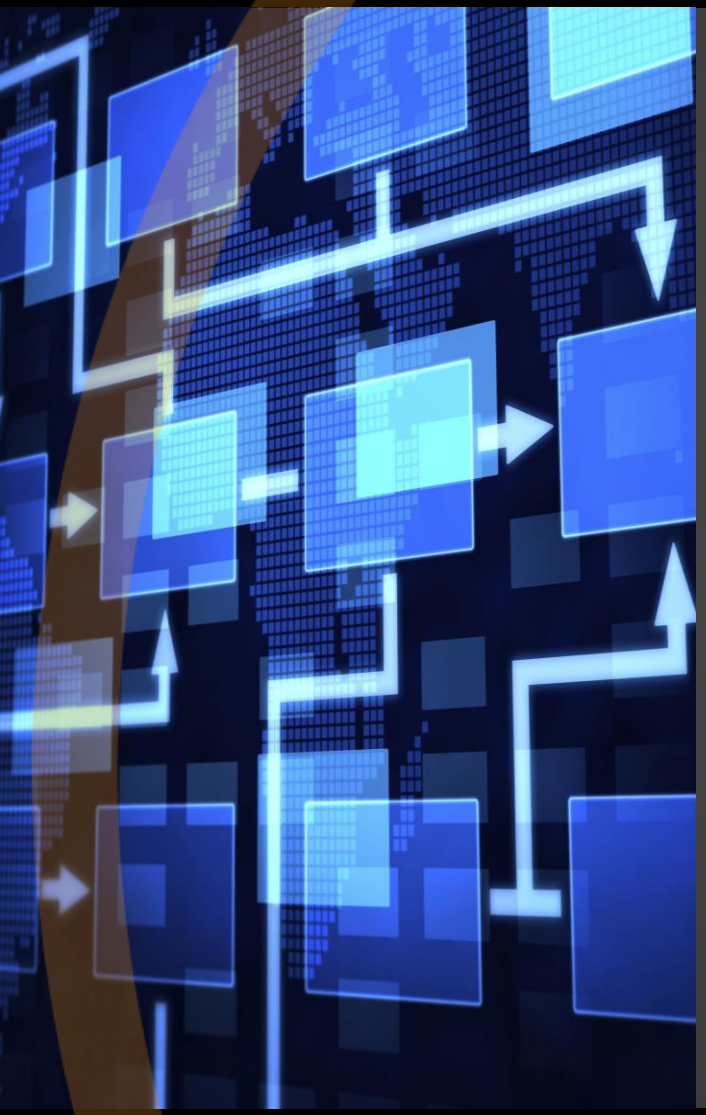
Order Flow

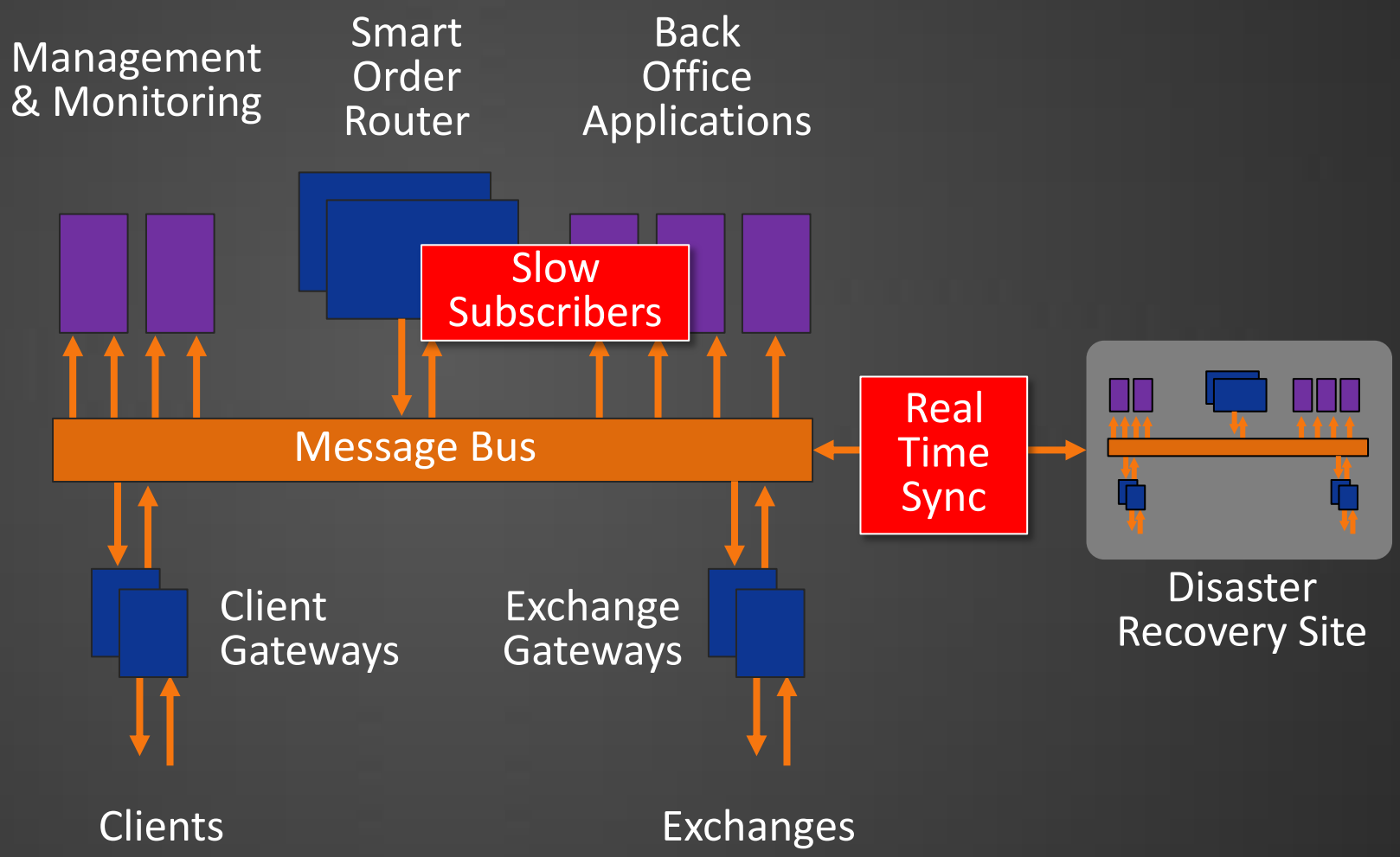


- Latency matters, but not every microsecond
- Usually localized
- Continuous, high-rate message flow
- Mid-sized messages (1-2Kb)
- Messages absolutely must be guaranteed

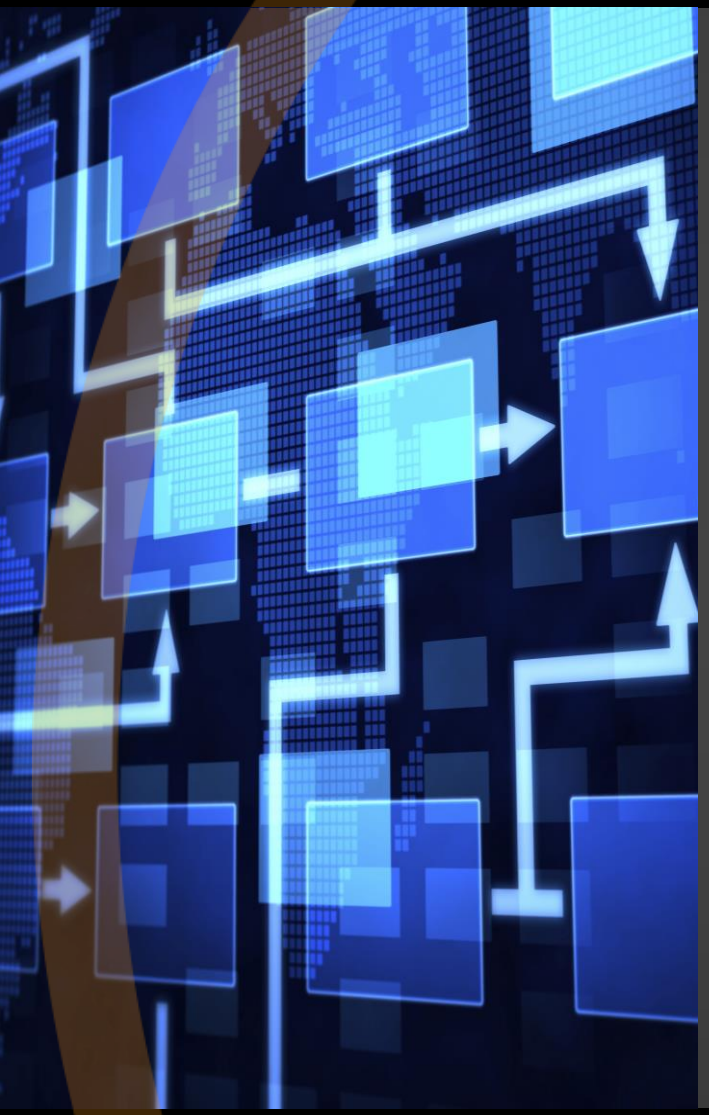


Order Flow; Architecture

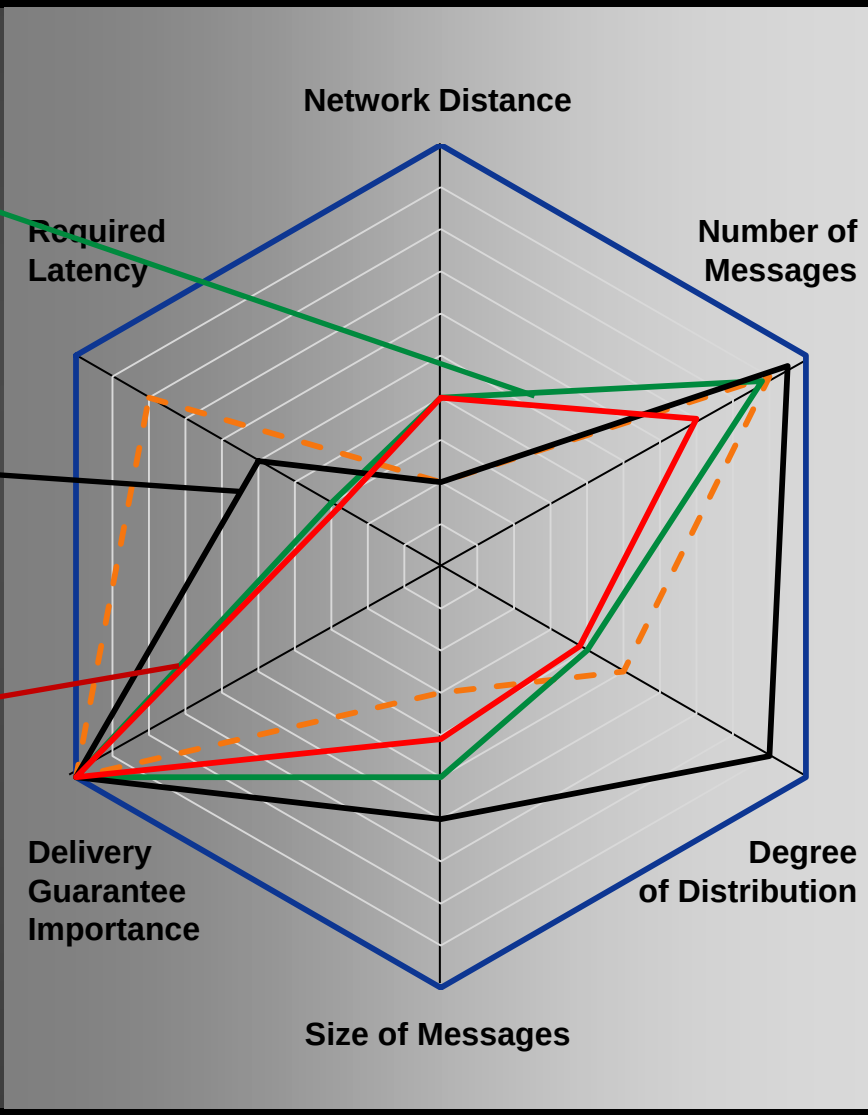




Order Flow;
Similar Use Cases



- Credit card processing
  - Long-distance WANs
  - latency in hundreds of milliseconds
- E-commerce
  - Higher volumes
  - Higher guarantee required
- Logistics scheduling
  - Less latency sensitive
  - More likely to include WANs



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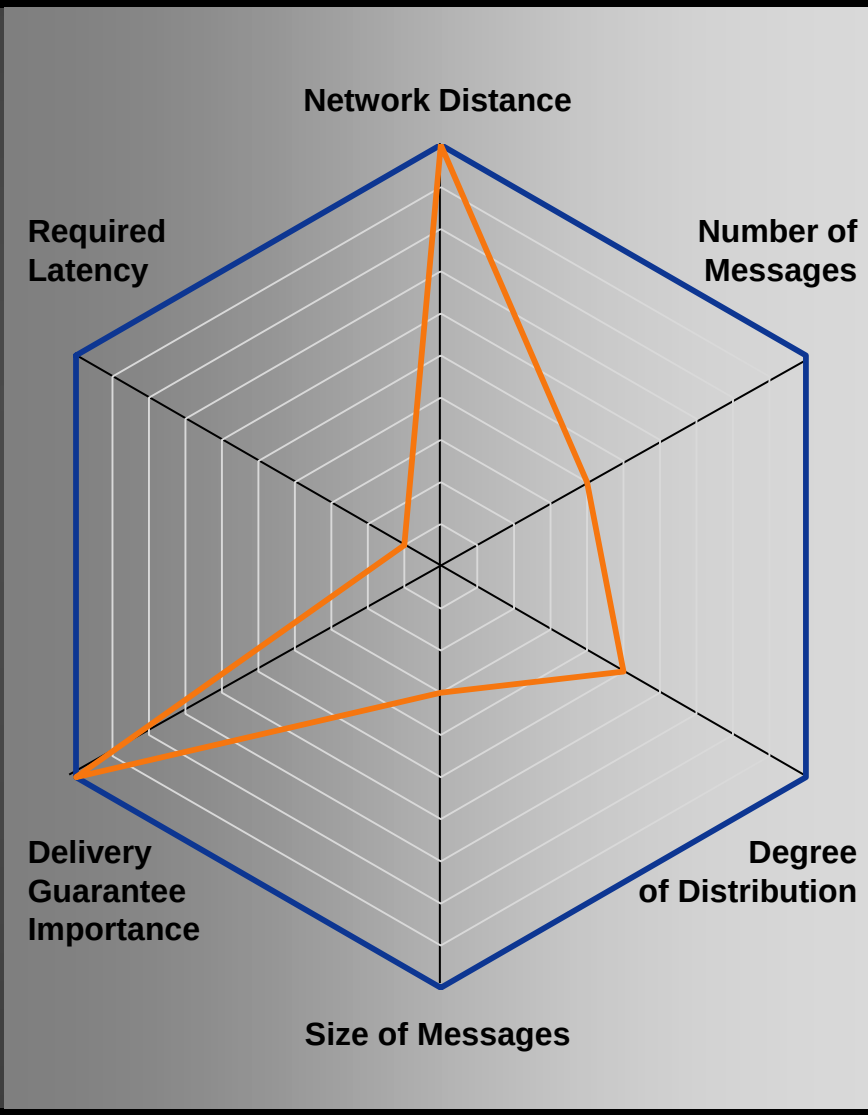
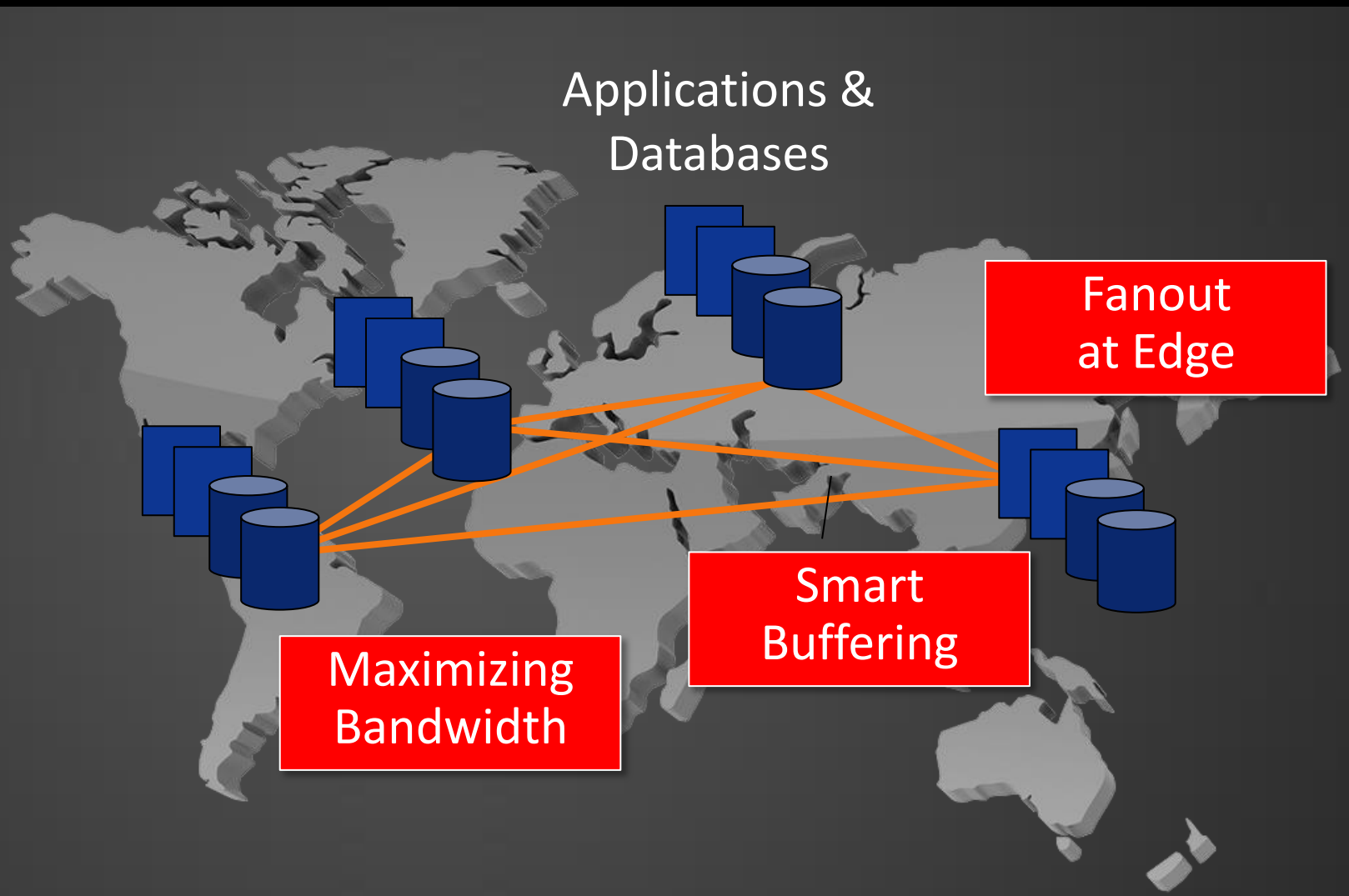
Manufacturing Data Sync

- Geographically distributed
- 100% delivery guarantee required
- Data rate is use case specific – will assume lots of medium (< 5K) messages.
- Number of endpoints use case specific, assume 10 manufacturing locations

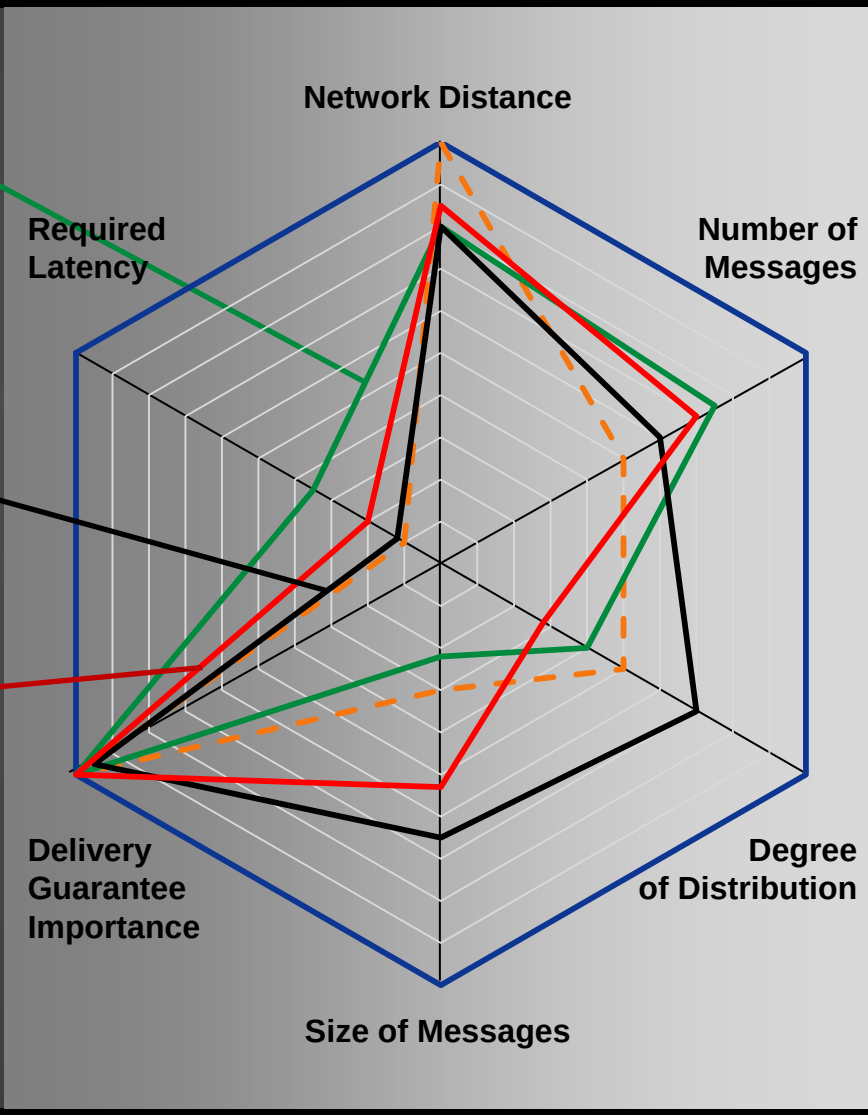


Manufacturing Data Sync; Architecture



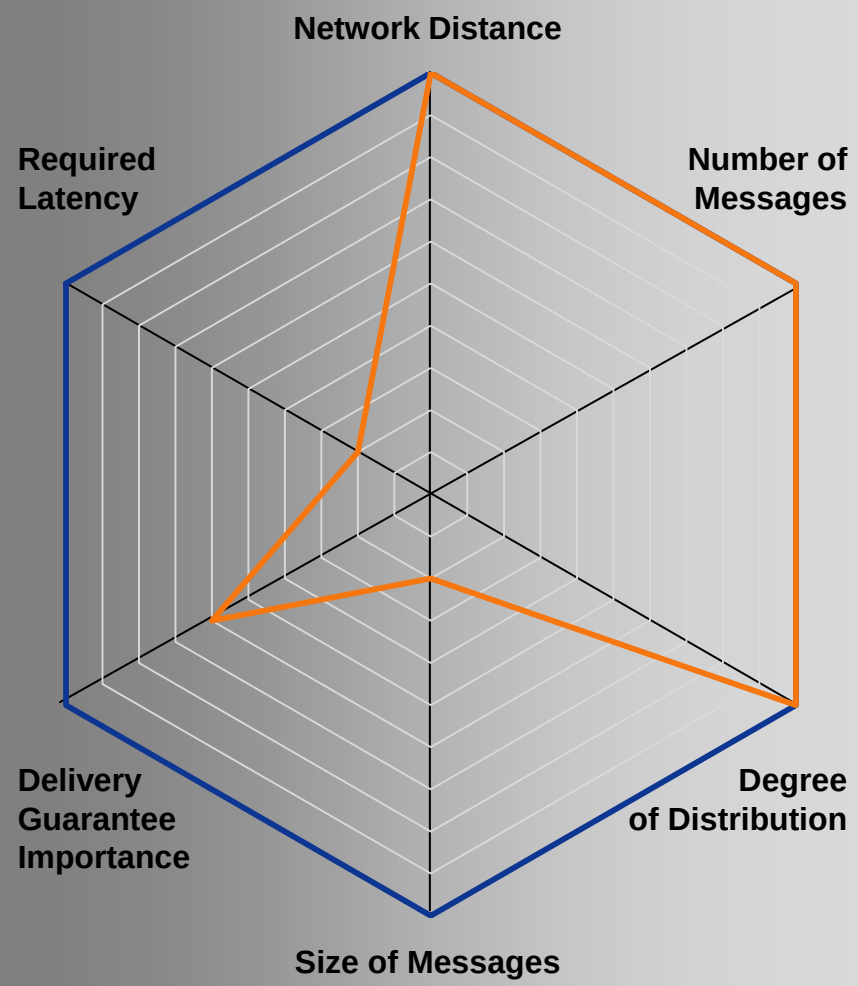
Manufacturing Data Sync; Similar Use Cases

- Real Time Risk Management
  - Smaller messages
  - Latency more important
- Retail Global Inventory
  - Messages can be larger
  - Distribution can be more
- Real Time Financials
  - Messages larger
  - Distribution less (collecting to 1 location)

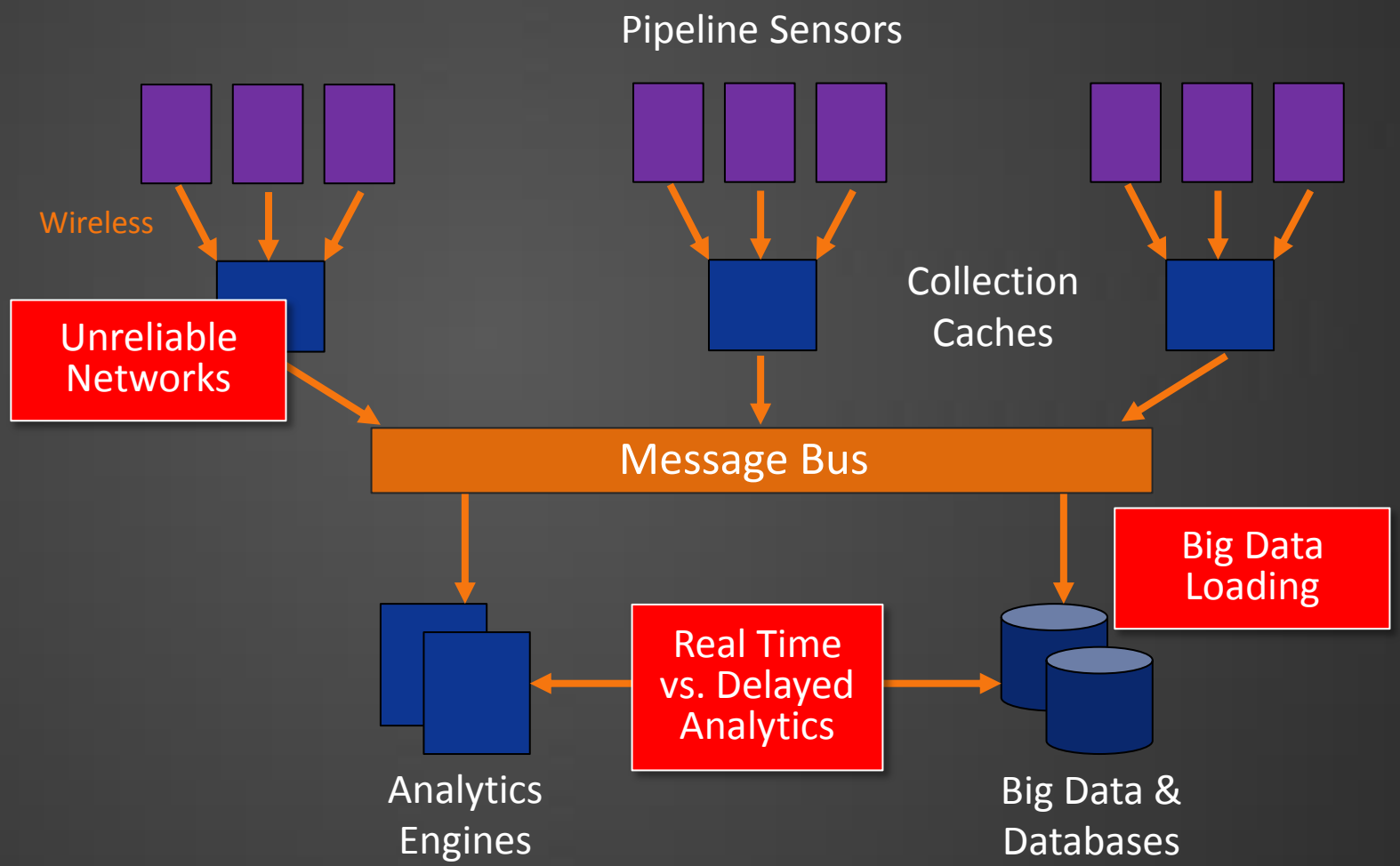


Oil & Gas Pipeline Monitoring

- Wifi, Satellite, proprietary and other unreliable networks
- Degree of distribution off the charts. In this case, fan-in.
- Messages usually pretty small, unless batch
- Latency unimportant
- Level of guarantee use case specific, assume status messages (ie. guarantee not essential)

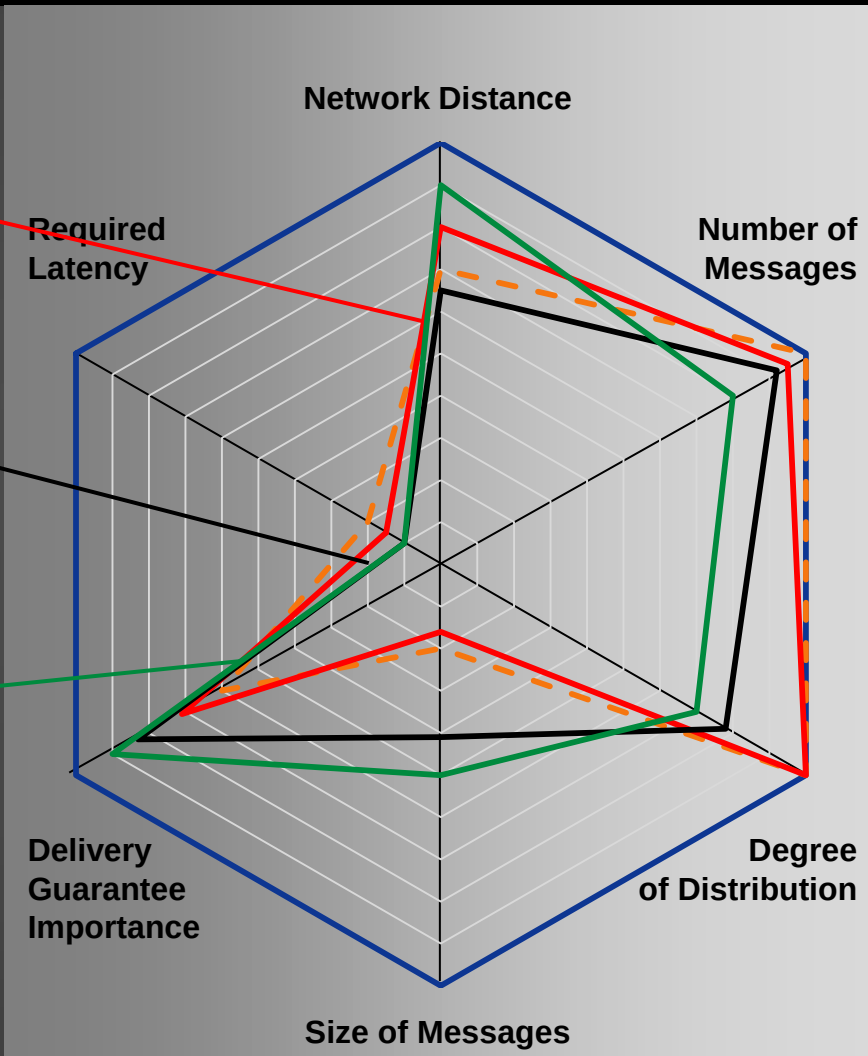


Oil & Gas Pipeline Monitoring; Architecture



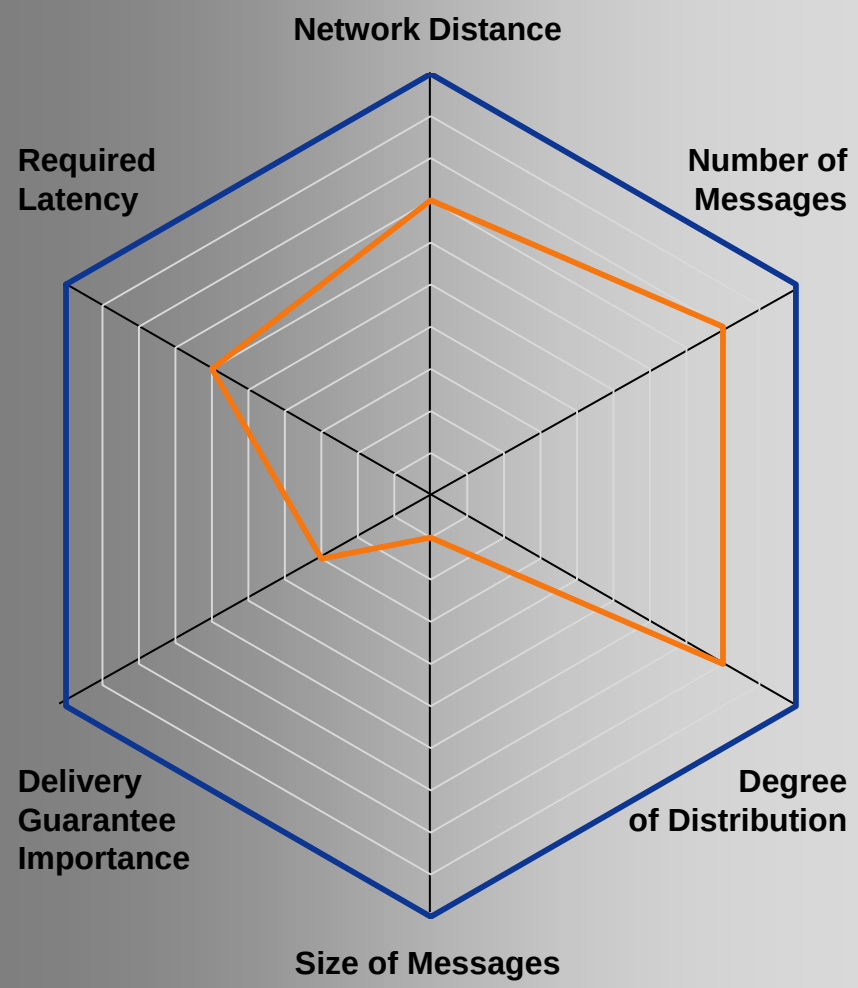
Oil & Gas Pipeline Monitoring; Similar Use Cases

- Smart Grid
  - Small messages
  - Massive distribution
- Transportation Monitoring
  - Fewer endpoints
  - Bigger messages
- Retail Point of Sale
  - More predictable networks
  - Guarantee more important

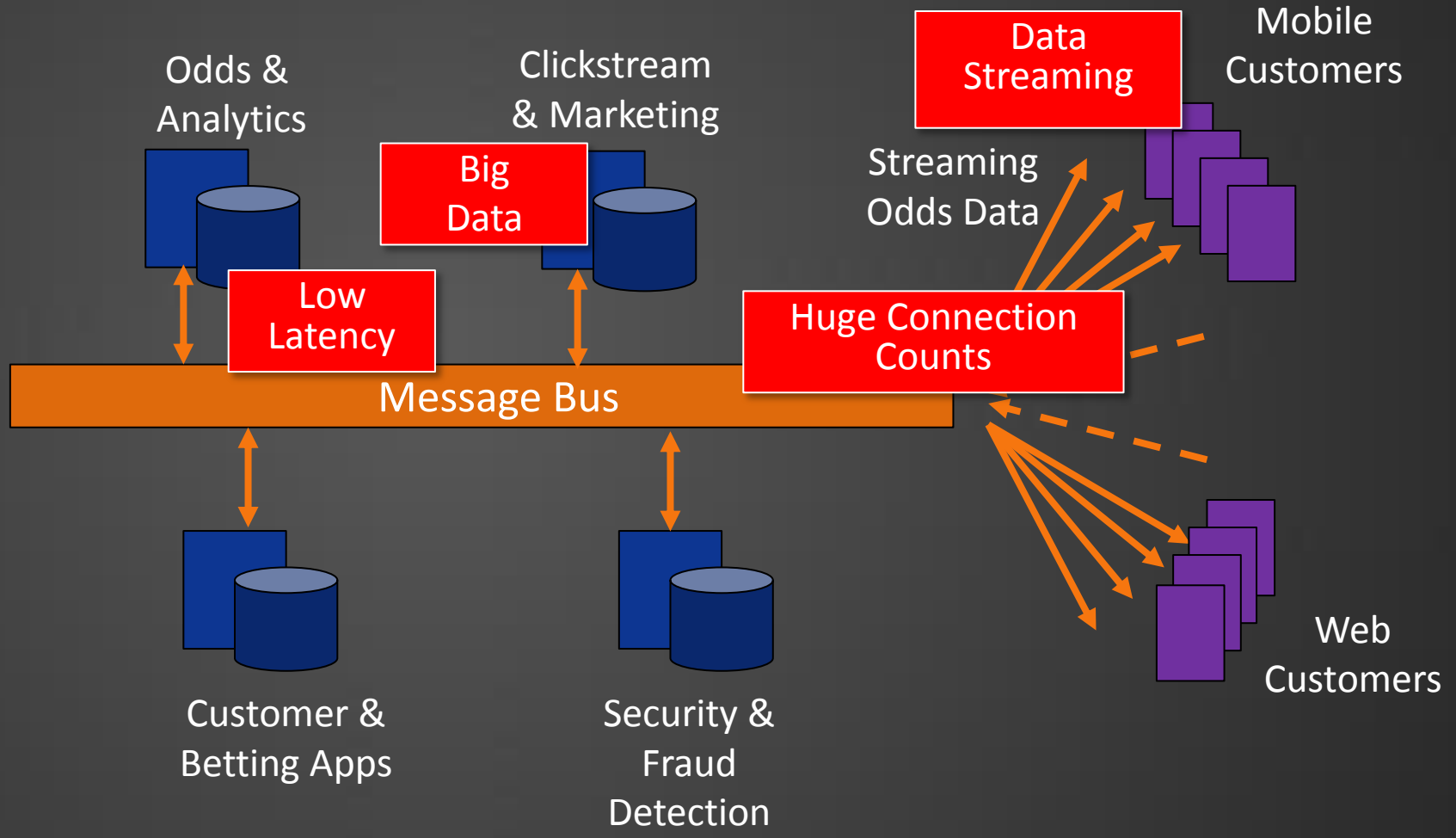


Real-Time Sports Betting

- Huge message volumes (in this case fan-out)
- Low level of guarantee for any one outbound message
- High level of guarantee for inbound messages
- Tiny messages
- Network is the internet + mobile carriers
- Latency (beyond network latency) is important



Real-Time Sports Betting; Architecture



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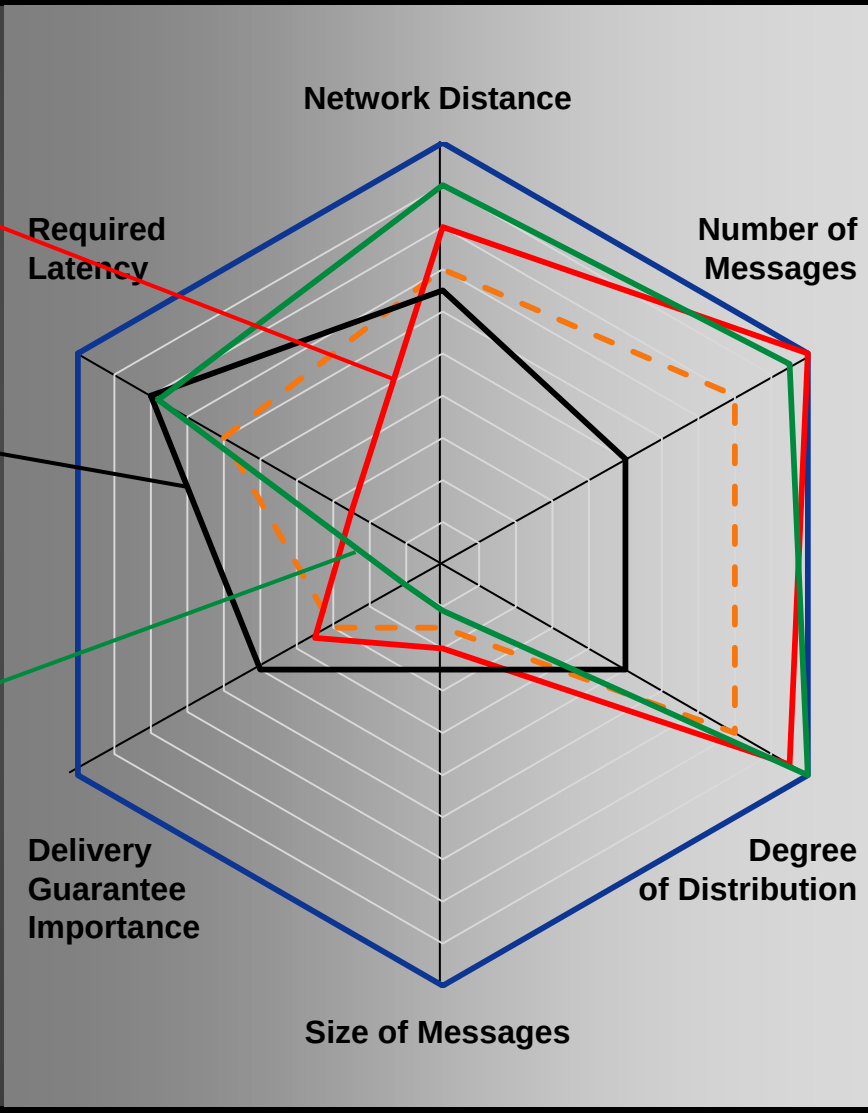
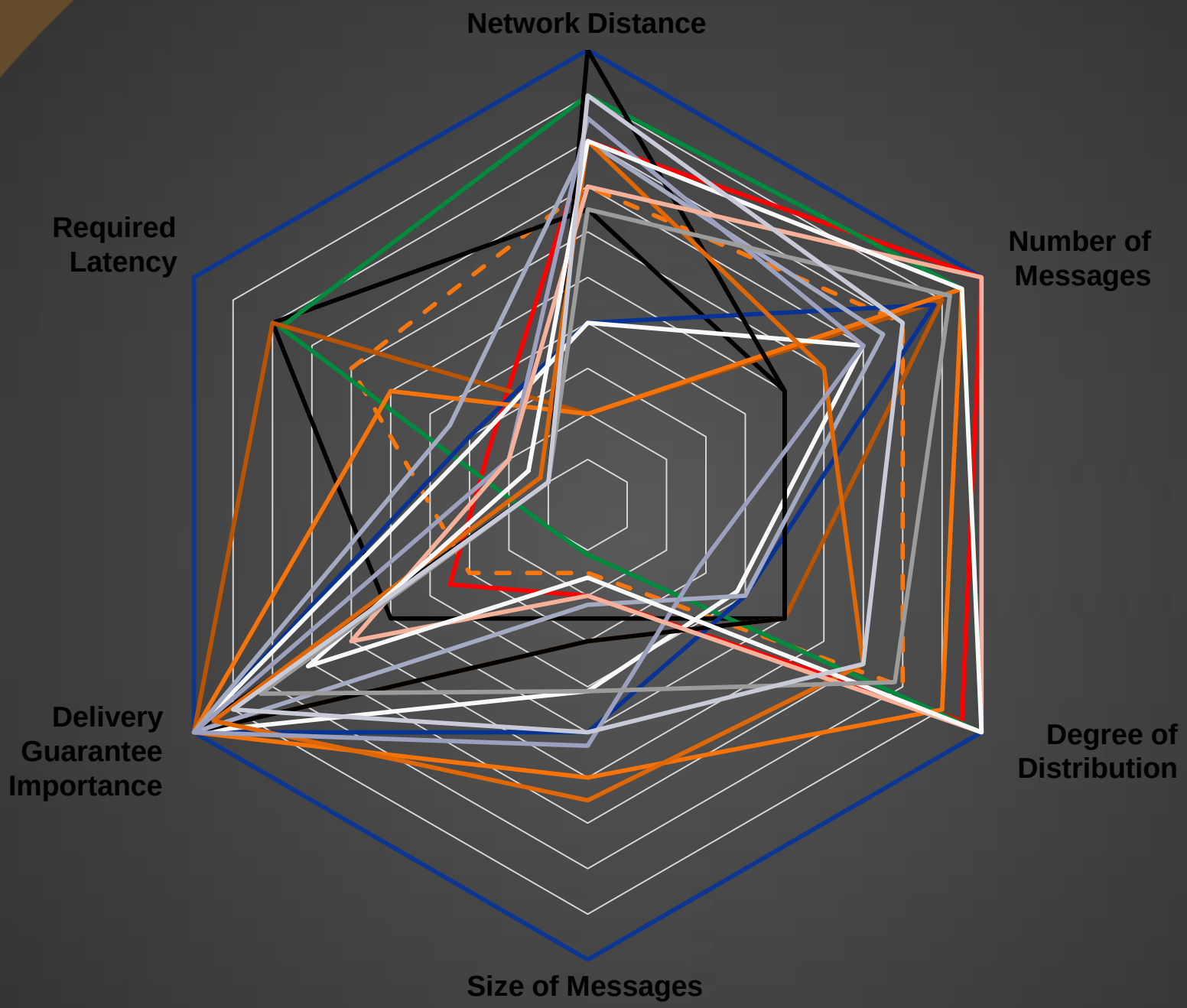
Real-Time Sports Betting; Similar Use Cases

- Mobile Social Updates
  - Latency less important
  - Distribution far greater
- Real Time Travel Alerting
  - Each message more important
  - Volumes much lower
- Market Data Distribution
  - Latency even more important
  - Volumes often much higher
  - Loss often tolerable




Network Distance
Number of Messages
Degree of Distribution
Size of Messages
Delivery Guarantee Importance
Required Latency

Summary