



Fog/Edge: Architecture and Applications

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@OpenFog #fogcomputing

Distribute Functions along C2T Continuum

- Architecture is “Horizontal Foundation”:
 - Who does what, at what timescale, how to glue them together?
 - Allocation of functions, not just resources
- Architecture supports Applications:
 - Source-channel separation: Digital communication
 - TCP/IP: Internet applications
 - Fog: IoT / 5G / Dispersive AI

Decomposition and Interfaces



Massive storage
Heavy duty computation
Global coordination
Wide-area connectivity



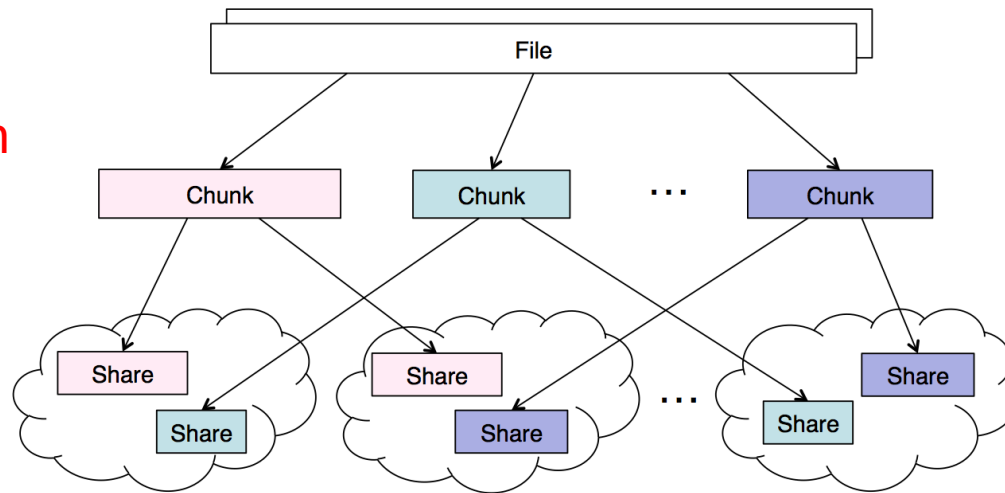
Real time processing
Rapid innovation
Client-centric
Edge resource pooling

Example: Shred and Spread (Myota)

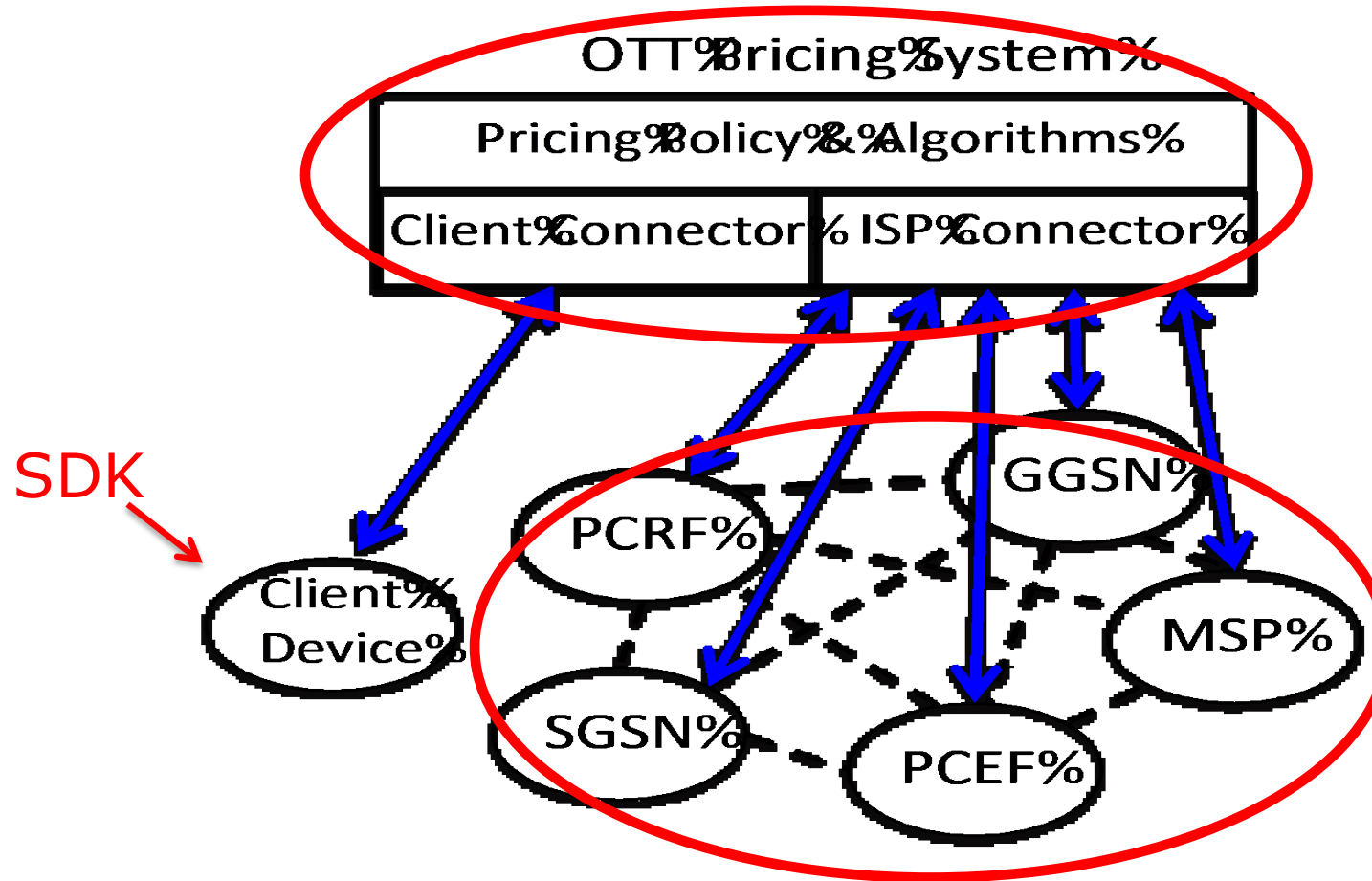
- Client-driven data processing for privacy protection and reliability
 - Scatter files to multiple fog storages
 - Client-side data deduplication
 - Obfuscated data in storages

File chunking
for **data deduplication**

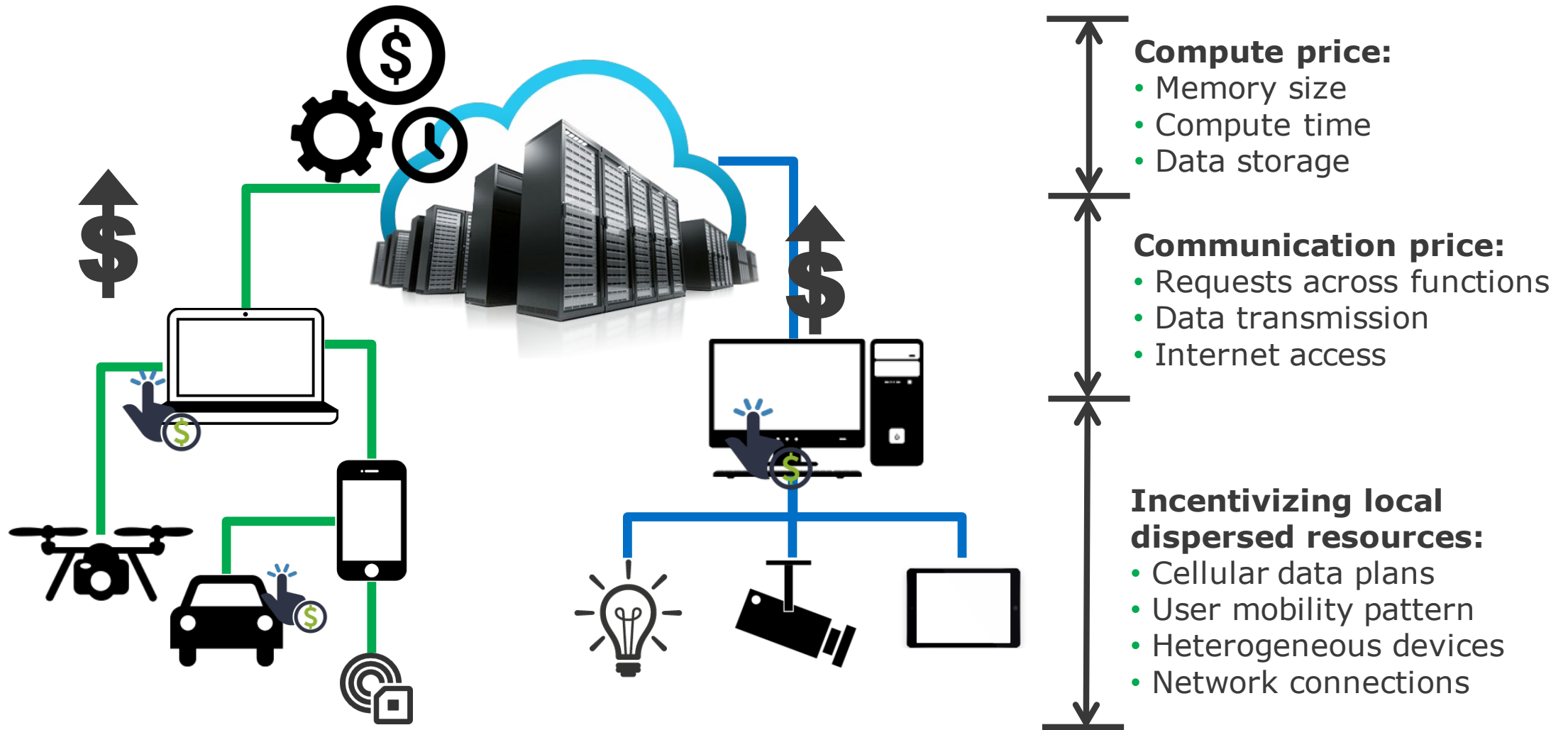
Chunk
encoding/spreading
for privacy and
reliability



Example: Smart Data Pricing (DataMi)



Example: Fogonomics (Smartiply)



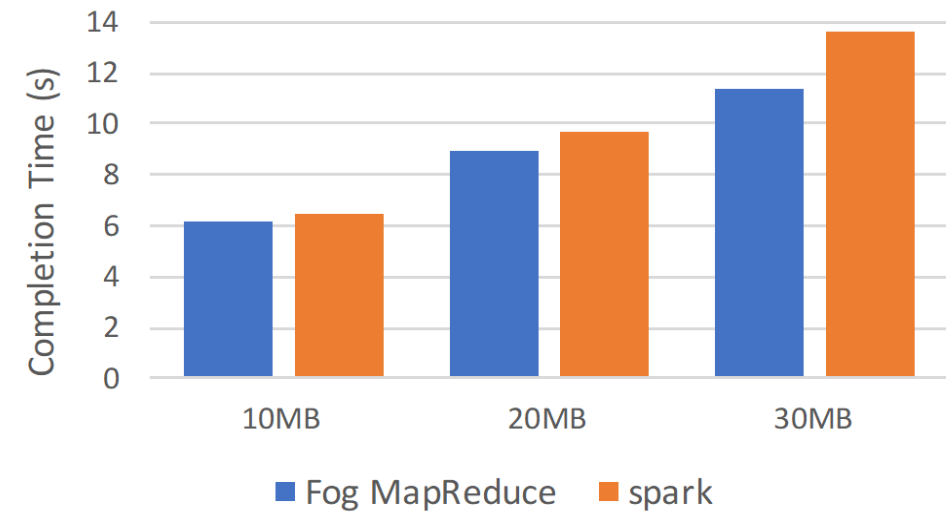
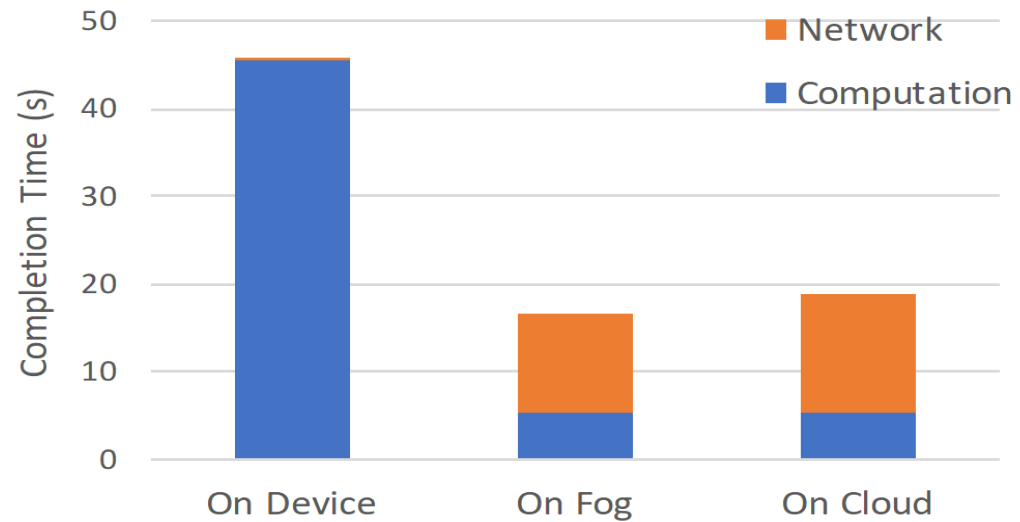
To Fog or Not to Fog: SCALE

- Security
- Cognition
- Agility
- Latency
- Efficiency

Applications to “Dispersive AI”

- Design machine learning algorithms that support **fast responses**
 - Enable IoT/CPS systems with intelligence here and now
- **Decompose machine learning** into multiple geographically distributed components, collectively or jointly operating
- **Proactively pre-position content and computing**
 - Parallel successive refinement for streaming mining

Case 1: New “MapReduce”

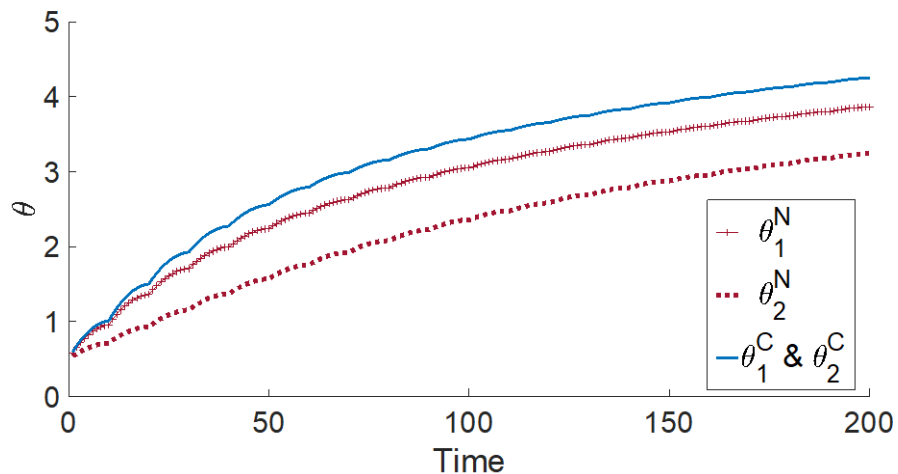


Case 2: Multi-Agent Reinforcement Learning

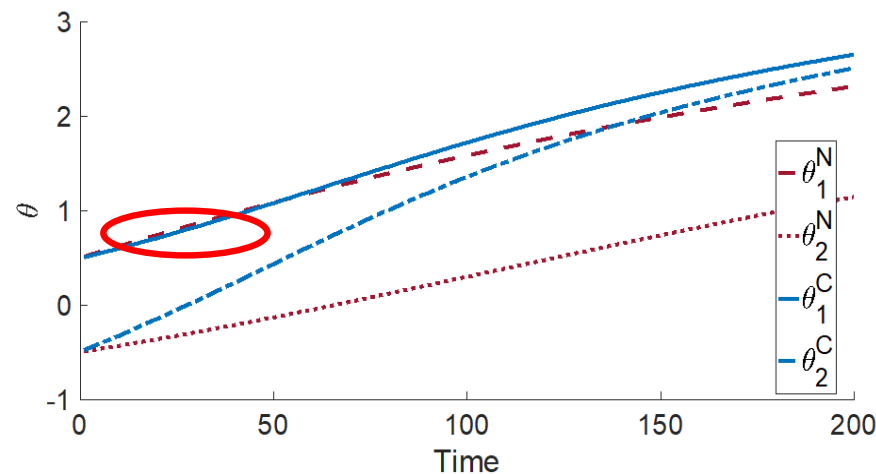
- Decentralized decision making by team of edge devices
 - Enable **coordination** towards common goal
 - **Learn to act** in an a priori unknown environment
- Augmenting RL algorithms with **inter-agent communication**
 - **Information heterogeneity** about the state of the environment
 - Informed agent 1 shares true state with a less informed agent 2

Promises and Pitfalls

Is current policy parameter θ such that the agent's policy places highest probability on the optimal action?



Yes: Improves learning of both agents



No: degrade learning in early stages

⇒ **Delayed sharing** might be better: wait for policies to improve, then start sharing

Unique Features in Edge/Fog

- Heterogeneity/Under-organization of resources/devices
- Variability/Volatility in availability/mobility
- Bandwidth/Battery constraints
- Proximity to sensors/actuators