

ECE 444 / ECE 544 /
CS 444 / CS 544

Supervisory Control and Critical Infrastructure Systems

Session 11

6/6-079

L11 1/6

CS&ECE 444/544
Lecture 10

Operational Technology-Characteristics

- Simplicity versus complexity
 - easy to make complex networks as capabilities grow
- Redundancy
 - documentation, verification, lease testing
 - no single point of failure
 - ↳ proven over time
- Security
 - ↳ ① operational → is it online
 - ↳ ② cybersecurity

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cost trade off

and workin right

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Lecture 10

Data Transmission

- what data?
 - communication requirements
 - update ~~data~~ rate
 - latency requirements — real time
 - how much data
- communication media
 - copper wires, fiber, wireless

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• communication architecture (topology)

- New installation (Greenfield)
- modify existing installation (Brown field)³

Communication protocols

Resilience of communication

Impacts: electromagnetic interference

- between equipment that radiates as part of its operation

- unexpected events (external events)

loss of signal
satellite
for time synchronization
for sync

- Power system faults

- degradation with distance

↳ repeaters

- Aging / failures of equipment
→ predictive maintenance schedules

spoofing

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Communication Considerations

- Applications using data (data types) - *what will comms system support?*
 - Separate system by application
 - SCADA
 - Protection
 - Distribution management systems
 - Synchrophasors (Phasor measurement unit) (Pmu)
- Resilience of the communication
 - How likely data will arrive *engineering access*
 - Resilience is ability to get minimum ~~oper~~ acceptable operation in face of unexpected disturbance



- Reliability is looking at what has happened and make sure it won't disrupt operation in future

Additional Considerations

- Quality of service - *speed, latency*
- Scalability - *Bandwidth / channel capacity needs*
- Security - *operational cyber security*
- Reliability *resilience*
- Affordability
- Maintainability



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Standardization & Interoperability

Allow Mixing Equipment from Vendors

- communication media/connectors supported by equipment
- interface
- connectivity (ability to talk to each other)



⇒ Protocols 2 format data frames

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↳ modbus
↳ DNP3

- IEC 61850
(other IEC)

Communication Topologies

- Physical versus logical
- Point to point ↳ programmed in switches
- Multidrop
- Bus
- Ring
- Star
- Mesh



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- Costs for a communication system

- Transmitters } transceivers
- Receivers }

- Repeaters

- media

↳ terminations (end points or at repeaters)

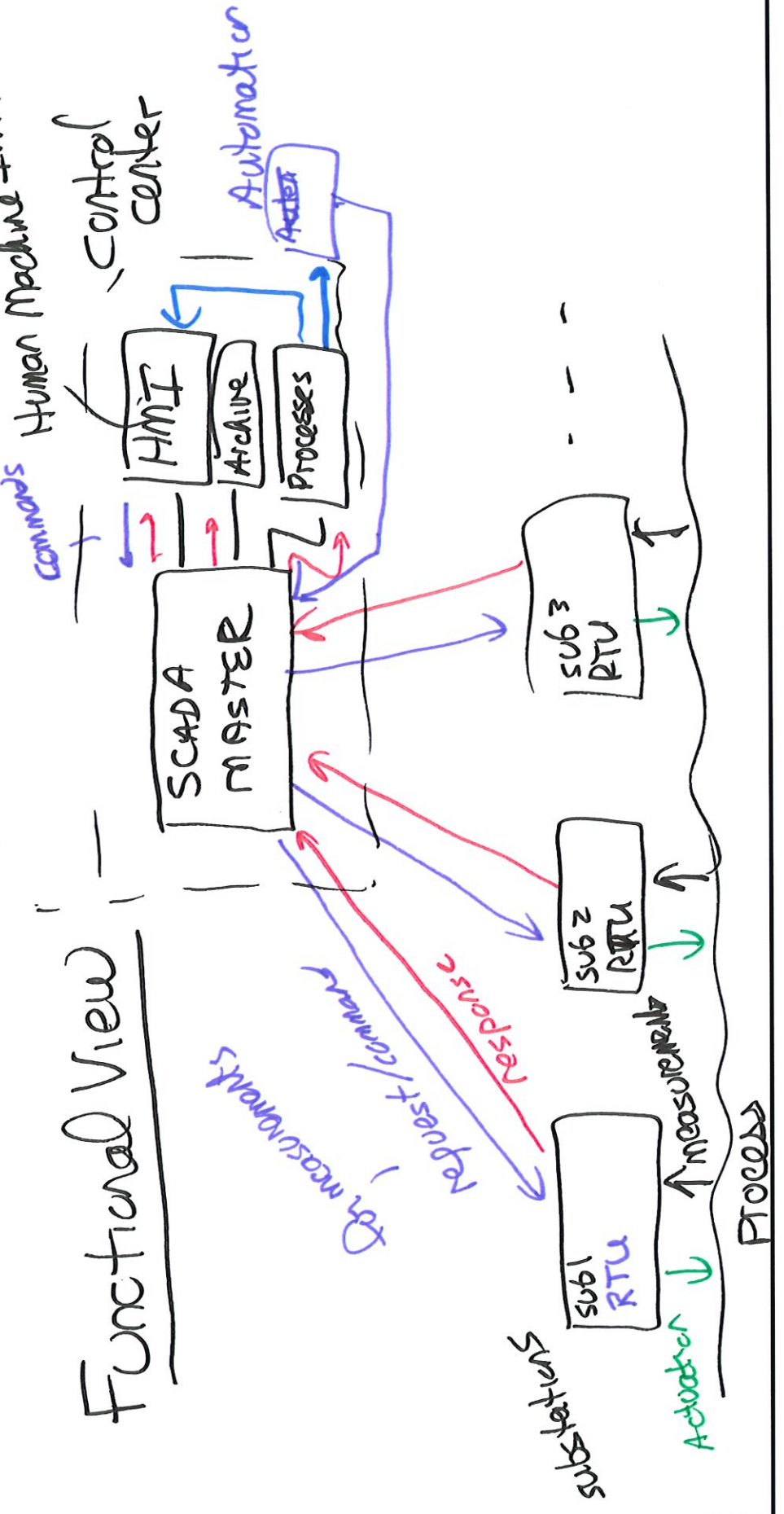
↳ splices

- Right of way cost

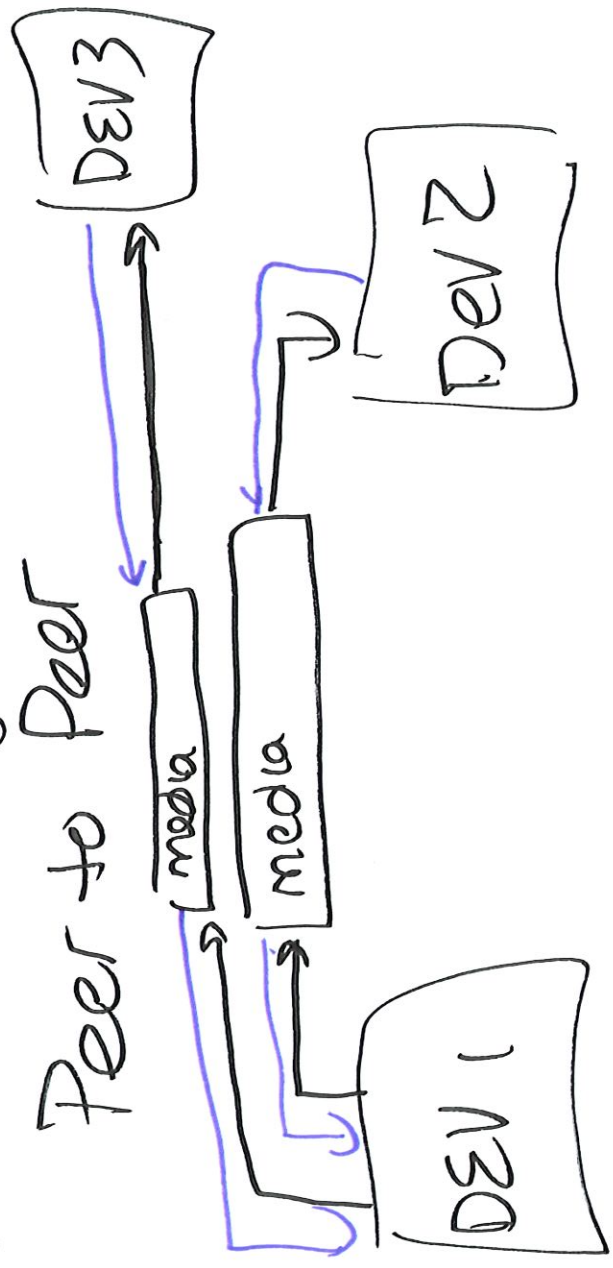
Architectures

- Supervisory Control and Data Acquisition (SCADA)
- Host/Client (Master/Slave)

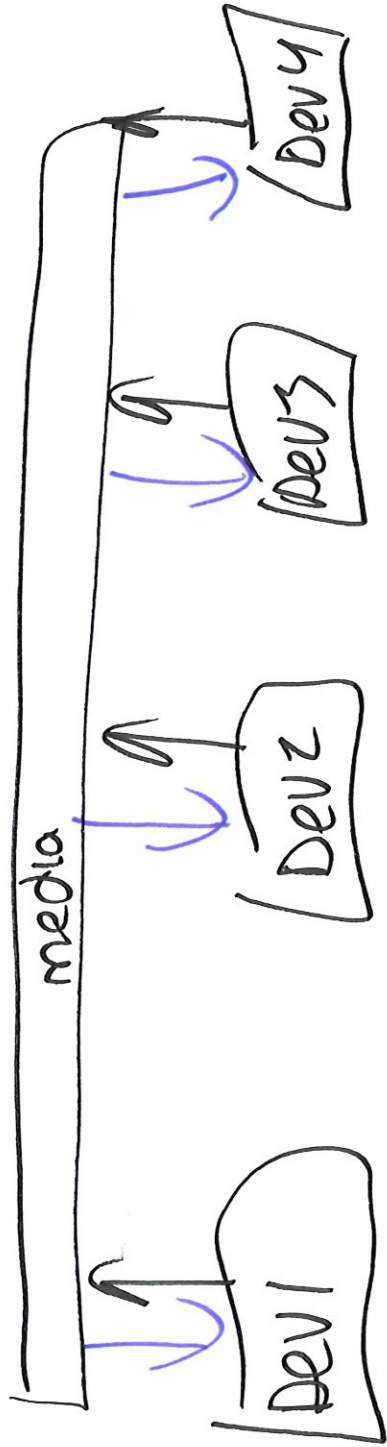
Functional View



Implementing ~~Peer to Peer~~ Architecture



Broadcast / Multicast



- Any message sent by one device is seen by all

- Dev can choose which to use or ignore }
Header info
- Who sent it?
- Who it was intended }