SIGNAL CONTROLLER

PEER-TO-PEER COMMUNICATIONS

Using advanced controller features to improve operations

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WHY PEER-TO-PEER
The Problem We’re Trying to Solve

• When signals are close together, they need to work together

• Time-base coordination sometimes isn’t good enough
  • Requires a fixed cycle length
  • If not the coordinated phase, downstream signal can gap out before traffic can arrive from upstream signal
  • Inefficient to coordinate very small groups of signals

• Adaptive control may also not be ideal
  • Expensive and complicated (although P2P isn’t exactly simple)
  • Adapts to the last cycle or cycles, not to immediate demand
When Time-Base Coordination Isn’t Ideal
Past Solutions

• Use a single controller
  • Some locations require more output channels than a single cabinet can provide, requiring two cabinets
  • Legacy locations built before controllers had capability to handle two intersections
  • Locations built with ease-of-maintenance in mind instead of operations

• Use custom-built interconnect logic
  • Pray that you never have a knock-down
New Solution

- Use modern controllers with capability for built-in logic AND peer-to-peer communications
Availability of These Features

• UDOT has successfully used controllers from:
  • Econolite (Cobalt controller/software)
  • Intelight (MaxTime software)
  • Siemens (NextPhase software, capabilities are limited by controller hardware)

• Other vendors may also offer similar features
No Standardization

• All controllers in a P2P network must be from the same manufacturer.
P2P CASE STUDY

Mountain View (SR-85) @ Daybreak Parkway

South Jordan, UT
Site Description

- 55mph Divided Highway
- Distance between 1\textsuperscript{st} and 2\textsuperscript{nd} stop-bar on cross-street is $\sim$370’
- Crashes
  - Some drivers have blamed crashes on confusion between downstream/upstream signals

Mountain View runs $\sim$N/S
Daybreak Pkwy runs $\sim$E/W
P2P Solution

- **Master/Slave**
  - Controller at NB side (master) times *all* movements for *both* sides
  - Controller at SB side (slave) times based on inputs from master – essentially an auxiliary output unit
Phasing

- Operates as a lag/lag 3-phase diamond

Red = Master Controller
Blue = Slave Controller
How Master Controls Phases at Slave

This programming is in the SLAVE controller’s ‘Logic Processor’

- When ‘Master Control’ is enabled and Comm is OK:
  - IF controlling phase in MASTER is GREEN or NEXT:
    - Call controlled phase in SLAVE
    - Apply hold to controlled phase in SLAVE
  - OTHERWISE
    - Omit controlled phase in SLAVE
    - Apply force-off to controlled phase in SLAVE
How Master Controls Peds at Slave

This programming is in the SLAVE controller’s ‘Logic Processor’

• When ‘Master Control’ is enabled and Comm is OK:
  • IF controlling ped in MASTER is timing WALK:
    • Call controlled ped in SLAVE
  • OTHERWISE
    • Omit controlled ped in SLAVE
Detector Calls

- Detectors are landed to local controller.
  - Detectors at NB side are landed to Master and place calls directly.
  - Detectors at SB side are landed to Slave and also place calls directly, but omits/calls/holds from Master can override.

This programming is in the MASTER controller’s ‘Logic Processor’

- When ‘Master Control’ is enabled:
  - IF there is an EXTEND or CHECK on controlled phase in SLAVE:
    - Place call/extend to controlling phase in MASTER

Similar logic exists for ped calls from the Slave controller.
Fail-Safes

- Master controller CANNOT control duration of any of these intervals in the Slave controller:
  - Minimum Green
  - Ped ‘Walk’
  - Ped Clearance (Flashing ‘Don’t Walk’)
  - Yellow Change
  - Red Clearance

- Master controller CAN override max green in Slave controller

- Master controller CANNOT override emergency vehicle preemption in Slave controller
Fail-Safes

• If Master stops cycling or loses communications with Slave, Slave could become “stuck” (with all phases omitted except the phase that is timing)
  • Slave contains logic that checks for following before applying omits/holds/force-offs:
    • Master is timing any phase (this also checks communications)
    • Master is not in flash
    • (In Econolite controllers) “Slave Release” flag in Master is OFF (this flag allows intentional operation as two isolated intersections)
    • (In Intelight controllers) There is no active call at the Slave that has gone unserved by the Master for more than 3 minutes
“Isolated” Operation

- Sometimes it may be desirable to operate the two controllers separately
  - Late at night
  - Construction or incident closing certain movements
  - Technician testing detection, etc.

- Custom logic includes ability to run “isolated” by time-of-day or manual override through central system
  - Econolite logic: Flag can be activated in Master controller. When active, Slave does not respond to phase/ped control and Master does not respond to inputs from Slave detectors
  - Intelight logic: Special sequence in Master that does not have barriers locking the rings together. Master still controls Slave but as an independent ring.
  - For technician testing, just unplug the Cat-5 cable at either controller
Time-base Coordination with P2P

- Sometimes TBC is desired at certain times of the day, such as to provide progression along an arterial.

- Coordination plans are entered into the Master controller only. Slave responds to Master controller the same whether Master is in “free” or “coord” mode.

- P2P is **still valuable** during coordination:
  - Both sides stay in step during pattern transitions
  - Coord phases don’t need to be on the movements between adjacent intersections – downstream signal will not gap out early
  - If oversized peds are used, both sides stay in step while recovering
RESULTS

Using Automated Signal Performance Metrics
Split Monitor

Controlling SB phase 8 at Master

Shows gaps (green) and max-outs (red) throughout the day, based on detector calls from Slave

Controlled SB phase 8 at Slave

Always shows “force-off” (blue) because it is under control of Master
Purdue Coordination Diagram – WB at Slave (downstream)

Before: 2/18/15

Coordination in AM and PM peak

Full Day AoG: 60%

After: 11/4/15

No time-base coordination

Full Day AoG: 76%
WRAP-UP
Things to Consider

• First implementation (in each controller type) takes many hours of research, development, and testing

• Subsequent implementations are easier, but still require extensive testing and documentation well beyond the level of a standard intersection

• Training required for maintenance and operations staff
QUESTIONS

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