SIGNAL CONTROLLER PEER-TO-PEER COMMUNICATIONS

Using advanced controller features
to improve operations

Matt Luker, P.E., PTOE

Utah Department of Transportation

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.

Doesn't
Work

P2P CASE STUDY

Mountain View (SR-85) @ Daybreak Parkway

South Jordan, UT

Site Description

- 55mph Divided Highway
- Distance between 1st and 2nd stop-bar on cross-street is ~370'
- Crashes
 - Some drivers have blamed crashes on confusion between downstream/upstream signals

Mountain View runs ~N/S
Daybreak Pkwy runs ~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

Matt Luker, P.E., PTOE

Utah Department of Transportation

mluker@utah.gov

801-887-3627