

The background features a warm, orange-toned aesthetic with several analog clocks and a calendar grid. The clocks are partially visible, showing numbers like 6, 7, 8, 9, and 10. The calendar grid is overlaid with numbers, including 7, 14, 28, 1, 8, 15, 22, 29, 2, 9, 16, 23, 30, 3, 10, 17, 24, 4, 11, 25, 5, 12, 19, 26, and 6, 13, 20, 27.

Bluetooth™ Based Travel Time Analysis

URS Corporation

Paul Slone, PE, PTOE

Our Problem – Data Collection

- Data Collection is...
 - **Time Consuming**
 - **Costly**
 - **The Most Difficult Area of Our Jobs**

Two Types of Data

- Origin-Destination
 - **Census Data**
 - **Driver Surveys**
- Travel Time
 - **Stopwatch**
 - **GPS**

Travel Time Methodologies

- Floating Car
- License Plate Survey

Both Have Significant Limitations

Limitations

- Floating Car
 - **Time Intensive**
 - **Limited Sample Data**
 - Number of Runs
 - Lacks Diverse Driver Data
 - Limited Movements
 - **Safety**
- License Plate Survey
 - **Time Intensive**
 - **Equipment Needs**
 - **Post Processing Errors**

Available Data

- Data Resources Are Everywhere
 - **It's In The Air**
 - **How Do We Capture It?**
 - **How Do We Leverage It?**



Bluetooth Sources

- Mobile Devices
 - **Phones**
 - **Earpieces**
 - **Some GPS Units**
 - **Computers**
- Vehicle Consoles
 - **GM OnStar®**
 - **Ford Sync System®**
 - **Built-in Hands Free Calling**

Travel Time Data Uses

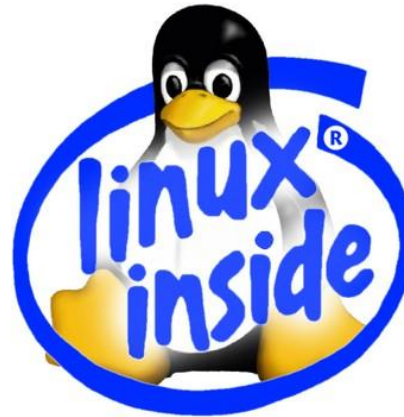
- Operations Performance Measure
 - Congestion Management Plans
 - Evaluation of Signal Systems
 - Before/After Signal Retiming
 - Freeway & Arterial ITS

Advantages of Bluetooth Methodology

- Increased Data Sample
- Cost Effectiveness
- Flexibility
 - **Variety of Valuable Studies**
 - **Temporary or Sustained Monitoring**
- Safety

Data Collection Unit

- Off The Shelf Equipment
 - Netbook / Field Hardened Computer
 - Bluetooth Receiver
 - External Antenna & Cable
 - Misc Hardware
 - Open Source Software

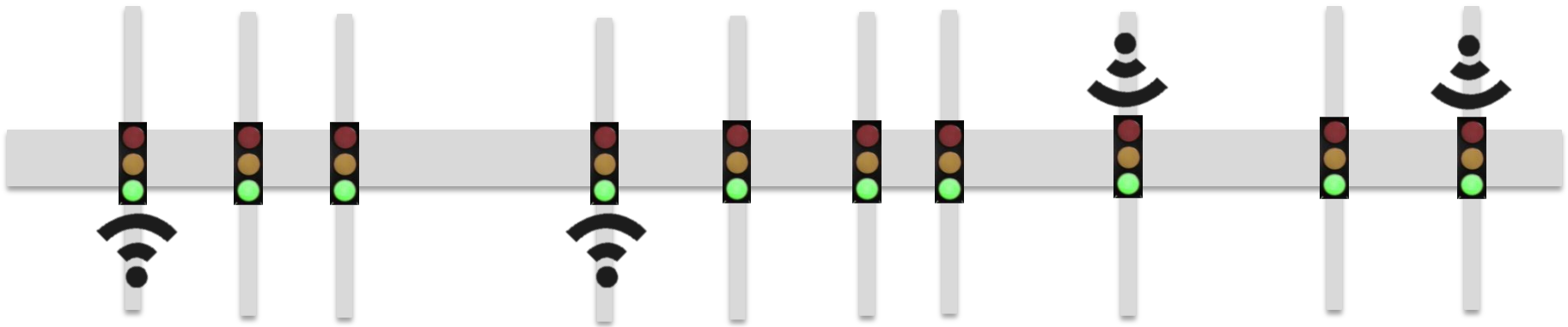


Installation



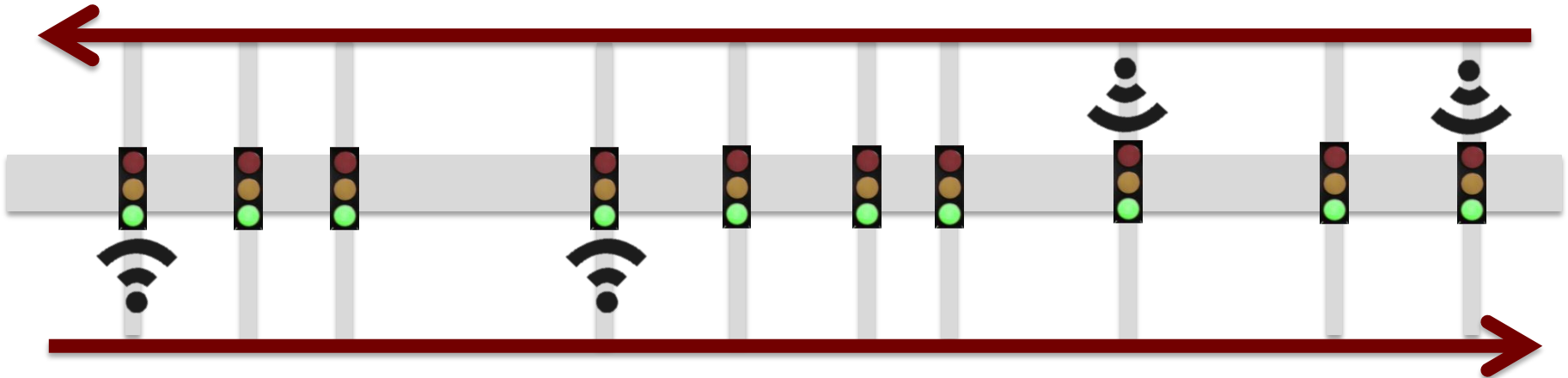
Equipment Deployment

- Multiple Sites
 - Not Necessarily Every Site
 - Distribute Based on Signals & Distance



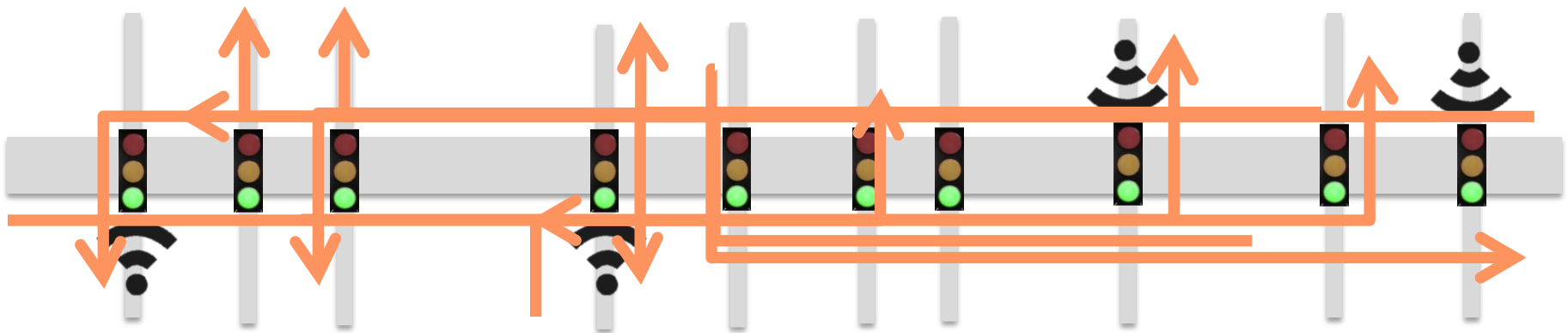
Strategy of Deployment

- Classic Traffic Engineering Methods
 - Favor Coast-to-Coast Analysis
 - Limited Focus



Strategy of Deployment

- What About Other Movements?
 - As Low as 20-25% Pass Completely Through
 - Sub-Routes Within Corridor



More Inclusive

- All Travelers
 - Through Traffic
 - Sub-Routes
 - Driver Types
- All Modes
 - Trucks
 - Transit

Data Stream

node3	81659	2/3/2011 11:12	0.247602	00:26:5F:5C:E2:6B
node3	81660	2/3/2011 11:13	0.259993	00:1F:82:58:F7:F8
node3	81661	2/3/2011 11:13	0.383064	00:26:5F:5C:E2:6B
node3	81662	2/3/2011 11:13	0.806822	00:1F:82:58:F7:F8
node3	81663	2/3/2011 11:13	0.972077	00:26:5F:5C:E2:6B
node3	81664	2/3/2011 11:13	0.80749	5C:17:D3:6E:E9:6B
node3	81665	2/3/2011 11:13	0.969103	00:1F:82:58:F7:F8
node3	81666	2/3/2011 11:13	0.103763	00:26:5F:5C:E2:6B
node3	81667	2/3/2011 11:13	0.440163	5C:17:D3:6E:E9:6B
node3	81668	2/3/2011 11:13	0.657196	00:1F:82:58:F7:F8
node3	81669	2/3/2011 11:13	0.843309	00:26:5F:5C:E2:6B
node3	81670	2/3/2011 11:13	0.32625	00:1F:82:58:F7:F8
node3	81671	2/3/2011 11:13	0.448877	00:26:5F:5C:E2:6B
node3	81672	2/3/2011 11:13	0.791573	00:1F:82:58:F7:F8
node3	81673	2/3/2011 11:13	0.979101	00:26:5F:5C:E2:6B
node3	81674	2/3/2011 11:13	0.85539	00:1F:82:58:F7:F8
node3	81675	2/3/2011 11:13	0.97843	5C:17:D3:6E:E9:6B
node3	81676	2/3/2011 11:13	0.328092	00:1F:82:58:F7:F8

Web Based Data Processing

Bluetooth Directional Antenna



Installs with no permanent damage to the cabinet, is inconspicuous, requires no special tools, and is highly sensitive.

We chose to make a bracket that mounts to the existing lifting lug holes so that it wouldn't leave any permanent damage to the cabinet. This mounting has proven to be simple as well as very effective.

Why the name "Bluetooth"?

The term, "Bluetooth" comes from a derivation of a descriptive Scandinavian word commonly added to King Harald I of Denmark's title. He united dissonant Danish tribes into a single kingdom. Bluetooth devices parallel this concept by integrating the communication between proprietary electronic devices via one universal standard.

Bluetooth Detection Project

Posted on April 8th, 2011

Bluetooth data and results coming soon.

bluetooth.ursconnect.com

Data Processing

- Python Based Web Script
- Numerous Data Filters
- Flexible Reporting Options

Filters

- Filter Data For Dates & Days Analyzed
- Delete Redundant Addresses
- Time Filter
- Travel Time Measured From Last Detected Address

Output

PM PRE-RUSH

PLAN 5

Northbound				Before Data			After Data			Comparison	
3:40 - 4:40 PM											
Nodes (From - To)	Cross Street	Distance	Posted Speed	Ave Link Trav Time	Average Speed	Number of Samples	Ave Link Trav Time	Average Speed	Number of Samples	Time Differential	Speed Differential
node21 - node22	Greenwood Rd. - Lowes	0.642	40MPH	94	23.6	41	91	24.4	62	-3	0.8
node22 - node23	Lowes - Trent Drive	0.543	40MPH	106	17.6	49	125	14.8	78	19	-2.8
node23 - node24	Trent Drive - Rockford Lane	0.925	40MPH	129	25.1	56	117	27.5	82	-12	2.4
node24 - node25	Rockford Lane - Heaton	0.645	40MPH	126	17.6	87	125	17.7	66	-1	0.1
Southbound											
Nodes (From - To)	Cross Street	Distance	Posted Speed	Ave Link Trav Time	Average Speed	Number of Samples	Ave Link Trav Time	Average Speed	Number of Samples	Time Differential	Speed Differential
node24 - node25	Rockford Lane - Heaton	0.645	40MPH	132	16.9	75	99	22.4	97	-33	5.5
node23 - node24	Trent Drive - Rockford Lane	0.925	40MPH	143	22.6	74	123	26.2	77	-20	3.6
node22 - node23	Lowes - Trent Drive	0.543	40MPH	76	24.4	58	70	26.4	87	-6	2
node21 - node22	Greenwood Rd. - Lowes	0.642	40MPH	113	19.6	50	87	25.4	89	-26	5.8

PM FLUSH

PLAN 6

Northbound				Before Data			After Data			Comparison	
4:40 - 5:40 PM											
Nodes (From - To)	Cross Street	Distance	Posted Speed	Ave Link Trav Time	Average Speed	Number of Samples	Ave Link Trav Time	Average Speed	Number of Samples	Time Differential	Speed Differential
node21 - node22	Greenwood Rd. - Lowes	0.642	40MPH	91	24.2	49	92	23.9	82	1	-0.3
node22 - node23	Lowes - Trent Drive	0.543	40MPH	99	18.7	56	129	14.3	80	30	-4.4
node23 - node24	Trent Drive - Rockford Lane	0.925	40MPH	117	27.7	52	117	27.6	88	0	-0.1
node24 - node25	Rockford Lane - Heaton	0.645	40MPH	102	21.7	69	123	18.1	89	21	-3.6
Southbound											
Nodes (From - To)	Cross Street	Distance	Posted Speed	Ave Link Trav Time	Average Speed	Number of Samples	Ave Link Trav Time	Average Speed	Number of Samples	Time Differential	Speed Differential
node24 - node25	Rockford Lane - Heaton	0.645	40MPH	96	23.2	99	78	28.5	109	-18	5.3
node23 - node24	Trent Drive - Rockford Lane	0.925	40MPH	157	20.6	78	133	24.2	79	-24	3.6
node22 - node23	Lowes - Trent Drive	0.543	40MPH	83	22.3	74	63	29.5	86	-20	7.2
node21 - node22	Greenwood Rd. - Lowes	0.642	40MPH	110	20	51	88	25.5	102	-22	5.5

Statistical Validity

- 2σ (sigma) Level of Confidence (+95%)
- 337 Samples 3,700 Vehicles (9%)
 - **Between Garrs & Crums Lane**

Before Data			After Data			Comparison	
Ave Link Trav Time	Average Speed	Number of Samples	Ave Link Trav Time	Average Speed	Number of Samples	Time Differential	Speed Differential
43	17	157	41	18.1	154	-2	1.1
74	16.8	68	66	18.8	64	-8	2
88	27.3	88	84	28.6	84	-4	1.3
94	28	80	94	28	88	0	0
Ave Link Trav Time	Average Speed	Number of Samples	Ave Link Trav Time	Average Speed	Number of Samples	Time Differential	Speed Differential
101	26	104	88	30	101	-13	4
87	27.5	96	84	28.7	106	-3	1.2
83	15	72	75	16.6	76	-8	1.6
62	11.9	179	45	16.2	183	-17	4.3

Validation Process

- Bluetooth vs. GPS
 - Different Antenna Types
 - Different Antenna Mounting
 - Refining Processing Script
- Validation Report in Progress (soon)

Business Case

- GPS Method 25-30% of Project Costs
- Final Analysis 10-15% of Project Costs

Practical Conclusion

- Multiple Uses
- Greatly Increases Data Sampling
- Cost Effective
- Significant Value



To Be Continued.....

The background features a warm, orange-toned aesthetic with several analog clocks and a calendar grid. The clocks are partially visible, showing numbers like 6, 7, 8, 9, and 10. The calendar grid is overlaid with numbers, and a large, semi-transparent clock face is prominent in the center, containing a calendar grid.

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