Developed for the
ITS Joint Program Office

ITS Technologies:
How Do I Prepare For a Career?

ITE Student Chapter Series

Technology is the Enabler

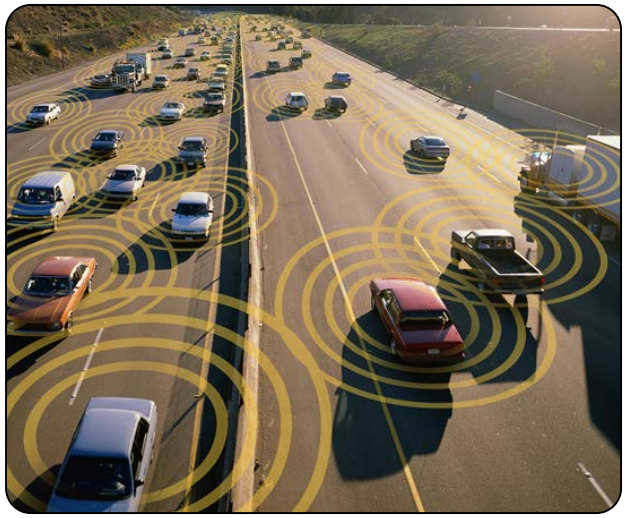
- Advanced Technology provides the ***Intelligence*** in ITS

- Technologies working together in a ***System*** provides the transformative power of ITS

- The aim is managing and operating the system in new ways to achieve unprecedented levels of efficiency and safety

Image Source: ThinkStock/USDOT

Core Disciplines Provide the Foundation



- Traffic Engineering
- Transportation Planning
- System Design and Integration
- System Management and Operation

. . . All working together

To deliver a transportation system with increasingly seamless integration across all modes

Image Source: ThinkStock/USDOT

Important ITS Elements

- Interoperability and Innovation
  - It is challenging yet vitally important to keep these in balance
  - Key Resources
    - ITS Architecture
      - National
      - Regional
    - ITS Standards
      - National
      - International
  - Systems Engineering provides the framework
    - Innovation to provide continually improved solutions
    - Guided by the National Architecture
    - Providing interoperability through standards compliance

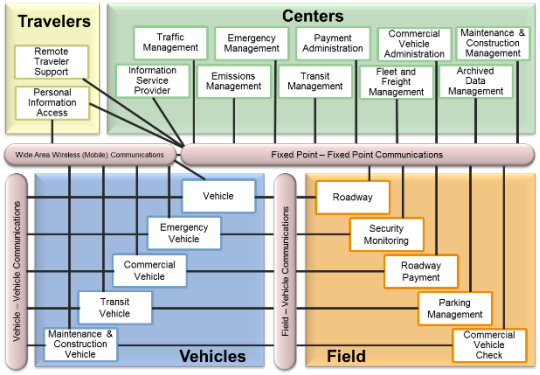


Image Source: National ITS Arch Web site
http://www.iteris.com/itsarch/index.htm

Image Source: ITS JPO Standards
https://www.standards.its.dot.gov/

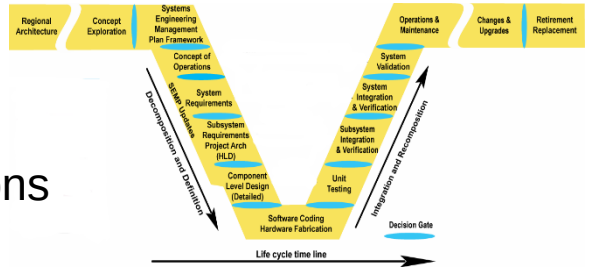
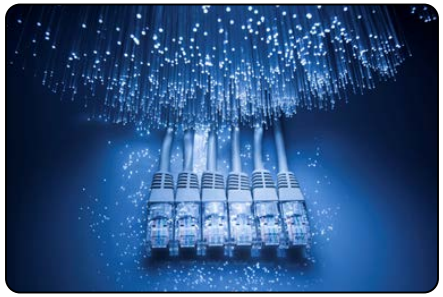


Image Source: *Systems Engineering Guidebook for ITS*
http://www.fhwa.dot.gov/cadiv/segb/

Important ITS Elements

- Secure Communications
  - Fiber networks for field devices



  - Wireless communications for mobile devices
    - Connected vehicles will bring an explosion in data
    - 4G LTE and Dedicated Short-Range Communications (DSRC) will both have a role

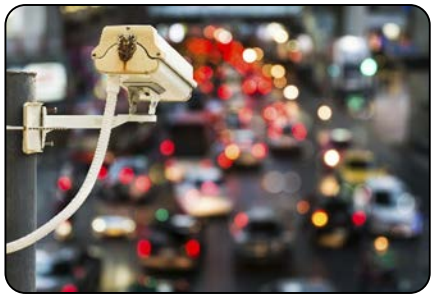
  - Data Security
    - Preventing System Attacks
    - Protecting Data Privacy

Image Source: ThinkStock/USDOT

The Key Components of *Intelligent Transportation Systems*

- ITS requires many complex subsystems working together as one
- **Intelligent Transportation Systems** combine –

Sensing



Communications

Information Processing

to achieve the goal of optimal efficiency and improved safety

Image Source: ThinkStock/USDOT

Going a Little Deeper

- Sensing
  - Field Devices
  - Vehicle Systems

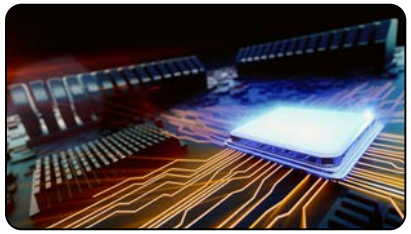
Image Source: Stadt Nürnberg – Copyright Free

Image Source: USDOT

- Communications
  - Landline
  - Wireless

Image Source: ThinkStock/USDOT

- Information Processing
  - Computing Hardware
  - Software Development
  - Network Modeling and Optimization



- All Aimed at Optimally Managing and Operating the Transportation System

Image Source: USDOT

Field Devices

- Increasingly sophisticated
- Will ultimately be integrated with connected vehicles

Image Source: www.daktronics.com

- Large Company Example
  - Daktronics – www.daktronics.com
  - Leader in ITS dynamic displays
  - Started by Electrical Engineering professors
    - First product was electronic voting systems

- Small Company Example
  - DigiWest – www.mybluemac.com
  - Provider of cutting edge Bluetooth data collection
  - Started as an networking
    and video conferencing services provider
  - Over 350 BlueMAC units deployed in Abu Dabi

Image Source: www.mybluemac.com

Vehicle Systems

- **O**riginal **E**quipment **M**anufacturer – Increasing scope and complexity
- Third party equipment – Fills interim gaps, i.e. aftermarket external cameras

- **USDOT/NHSTA**
  - **Vehicle to vehicle communication** – Federal rulemaking in 2016
  - **Rear visibility systems** will be **required** on all new vehicles **beginning May 2018**
  - Congressional action to **require crash avoidance system information** to be included in **NHTSA 5 star safety rating system**

- **Connected Vehicles**
  - **Third party services** like DASH are already providing vehicle to server connectivity for **personal driver performance feedback**
  - Navigant Research predicts that **DSRC OEM connectivity** will begin to **increase rapidly in 2016**
  - **V2X** – Includes vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), vehicle-to-pedestrian (V2P), vehicle-to-cyclist (V2C), etc. is part of ultimate vision

Communications

- Field Devices
  - Fiber will rule for –
    - Surveillance Cameras
    - Dynamic Message Signs (will these become obsolete?)
    - Infrastructure-based traffic detection
    - Networked Regional Traffic Management Centers

- Connected Vehicles
  - DSRC will be the workhorse for V2X
  - 4G LTE
    - Definite – Personal connectivity and communication for systems such as OnStar
    - Possible – Some of the load envisioned for DSRC

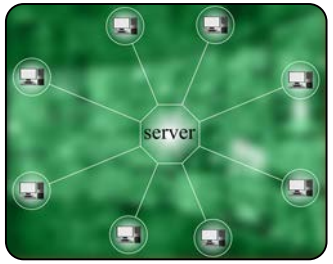
- Data and System Security will be **Paramount**
  - How vulnerable will wireless communications be?
  - "Hacking of Connected Vehicles Shifts
    From Theory to Very Scary"
    (July 24, 2015 – Paul Eisenstein) NBC Business

Image Source: ThinkStock/USDOT

Computing Hardware

- There may not be a need for special ITS computing systems

- However, there will be specialized unit server and client-server network designs



- IT departments have burgeoned in state departments of transportation

Image Source: ThinkStock/USDOT

Software Development

- Excellent opportunities to help deliver the complex software that will be needed to –
  - Manage truly **Big Data** streams
  - **Data analytics** and data fusion
  - **Integrate** data and management systems **across regions and modes**

- ITS market has been lead to date by

  specialty software/system integrator firms

- . . . However, major software and systems market players such as IBM, Cisco, and SAS are beginning to join the game

Image Source: ThinkStock/USDOT

Network Modeling and Optimization

- Traffic engineering
  - grounded in traffic flow theory
  - Modeling and optimizing transportation networks

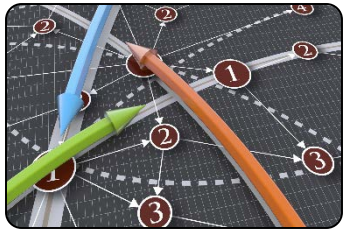
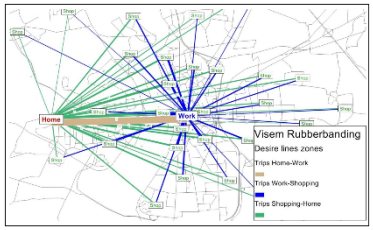


Image Source: USDOT

- Multi-level modeling will be essential, i.e. micro, meso, and macro-scale



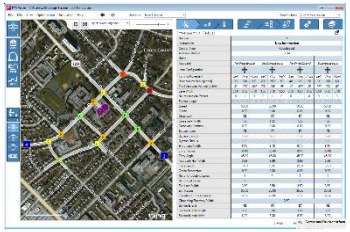


Image Source: company.ptvgroup.com/

- Example PTV Group
  - German company begun in 1979
  - First software was for planning
  - Now a global leader in transportation modeling from planning (Visum), traffic analysis (Vistro), and microsimulation (Vissim)
  - http://company.ptvgroup.com/en/home/
  - Vissim demo video

Do You Feel Prepared?

- What was the primary aim of the traditional civil/transportation curriculum?
  - **Build** and maintain the **Interstate Highway System**

- The new reality is about **efficient and safe management** and **operation** of an increasingly **integrated system** in a **data rich environment**

- Curricula are evolving to include ITS and supporting disciplines of systems engineering and database and network fundamentals

Image Source: ThinkStock/USDOT

Important Research on the ITS Workforce

- **NCHRP 20-77 Transportation Operations Framework (completed 2009)**
  - Defined required competencies for employees at all levels
  - Cataloged training resources
  - Identified gaps in training

Position Levels

Senior Management ↔ Mid-level ↔ Technician

Core Functions

- Policy and Strategic Considerations
- Program Planning
- Systems Development
- Project Management
- Real-time Operations

NCHRP 20-77
Operations Framework

CORE FUNCTIONS	POSITION						
	Senior Management		Mid-Level or Project Related (HQ or regional)			Technician/Field Personnel	
	Central Office Headquarters	Regional Management	Program Planning & Project Managers	Technical Specialists	Operations Managers	TMC (inside)	Field (Outside)
Policy and Strategic Considerations	Policy Development Public Outreach Strategy Development Organizational Change Management	Policy Development Public Outreach Strategy Development Organizational Change Management	Policy Development Public Outreach Strategy Development Organizational Change Management	Policy Development Public Outreach Strategy Development Organizational Change Management			
Program Planning	Business Process Mgmt Organization & Staffing Link Between Ops & Planning	Business Process Mgmt Organization & Staffing Link Between Ops & Planning	Business Process Mgmt Organization & Staffing Link Between Ops & Planning	Business Process Mgmt Organization & Staffing Link Between Ops & Planning	Business Process Mgmt Organization & Staffing Link Between Ops & Planning		
Systems Development			SE Process/Methods Systems Architecture DB Mgmt for Ops Prog. Languages & Tech. Visualization Network Security	SE Process/Methods Systems Architecture DB Mgmt for Ops Prog. Languages & Tech. Visualization Network Security	SE Process/Methods Systems Architecture DB Mgmt for Ops Prog. Languages & Tech. Visualization Network Security	SE Process/Methods Systems Architecture DB Mgmt for Ops Prog. Languages & Tech. Visualization Network Security	
Project Management	Contract Mgmt Outsourcing Contract Mgmt Procurement In-House PM Risk Mgmt		Contract Mgmt Outsourcing Contract Mgmt Procurement In-House PM Risk Mgmt		Contract Mgmt Outsourcing Contract Mgmt Procurement In-House PM Risk Mgmt	Contract Mgmt Outsourcing Contract Mgmt Procurement In-House PM Risk Mgmt	
Real-time Operations	Operations Strategies Systems & Tech. Safety Security Mgmt of RTO Systems	Operations Strategies Systems & Tech. Safety Security Mgmt of RTO Systems	Operations Strategies Systems & Tech. Safety Security Mgmt of RTO Systems	Operations Strategies Systems & Tech. Safety Security Mgmt of RTO Systems	Operations Strategies Systems & Tech. Safety Security Mgmt of RTO Systems	Operations Strategies Systems & Tech. Safety Security Mgmt of RTO Systems	Operations Strategies Systems & Tech. Safety Security Mgmt of RTO Systems

Important Research on the ITS Workforce

- **NCHRP 20-86 Attracting, Recruiting, and Retaining Skilled Staff for Transportation System Operations and Management (completed 2011)**
  - Provided strategies and resources
  - All 50 states surveyed
  - **"Network systems and data communications analysts"** category consistently had the **highest growth in number of jobs** across all states and regions

Exhibit A-1
NORTHEAST- Historical Occupational Change Summary 2005-2010

SOC Code	DOL Standard Occupation Title	# of 2005 Jobs	# of 2010 Jobs	Change	% Change	Education Level
15-1081	Network systems and data communications analysts	59,523	69,526	10,003	17%	Bachelor's degree
49-9097	Signal and track switch repairers	4,857	5,295	438	9%	Moderate-term on-the-job training
43-5031	Dispatchers	19,054	20,317	1,263	7%	Moderate-term on-the-job training

Exhibit A-3
WEST- Historical Occupational Change Summary 2005-2010

SOC Code	DOL Standard Occupation Title	# of 2005 Jobs	# of 2010 Jobs	Change	% Change	Education Level
15-1081	Network systems and data communications analysts	73,995	88,349	14,354	19%	Bachelor's degree
43-5031	Dispatchers	14,600	16			
49-9097	Signal and track switch repairers	7,380	7			

Network systems and data communications analysts

Exhibit A-2
MIDWEST- Historical Occupational Change Summary 2005-2010

SOC Code	DOL Standard Occupation Title	# of 2005 Jobs	# of 2010 Jobs	Change	% Change	Education Level
15-1081	Network systems and data communications analysts	60,617	69,639	9,022	15%	Bachelor's degree
43-5031	Dispatchers	20,031	21,277	1,246	6%	Moderate-term on-the-job training
49-9097	Signal and track switch repairers	7,696	8,169	473	6%	Moderate-term on-the-job training

Exhibi
SOUTH- Historical Occupationa

SOC Code	DOL Standard Occupation Title	# of 2005 Jobs	# of J			
15-1081	Network systems and data communications analysts	109,229	12			
49-9097	Signal and track switch repairers	11,771	13			
43-5031	Dispatchers	36,517	40,349	3,832	10%	the-job training

Top occupation area in each region in terms of both number of jobs and percent change!

Resources Available to You

- ITS ePrimer
  - Available for free at https://www.pcb.its.dot.gov/ePrimer.aspx
  - Fourteen modules from an *Introduction to ITS* through *Emerging Issues*

- Talking Technology and Transportation (T3) Webinars
  - Available for free at https://www.pcb.its.dot.gov/t3_webinars.aspx

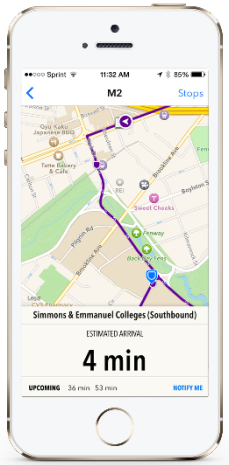
- Consortium for ITS Training and Education (CITE)
  - For fee with some free introductory modules
  - Certificate training
  - Modules are free for university students at CITE partner institutions
  - See http://www.citeconsortium.org/

- National Highways Institute (NHI)
  - Web and classroom based courses on software tools and transportation management
  - See http://www.nhi.fhwa.dot.gov/

- Info on these and other resources are available at –
  ITS Courses and Training – https://www.pcb.its.dot.gov/courses.aspx

Case Study 1

- TransLōc – Advanced Technology for Transit
  - Started in 2002 as an entrepreneurial leap by NC State University computer science grads
  - Original focus was rider service to provide real-time bus location
  - Services have expanded to cutting-edge fleet and system operations management support



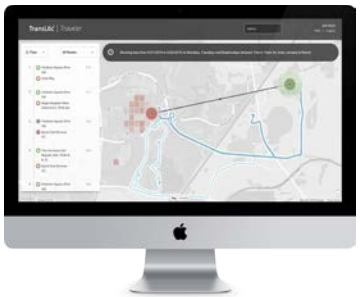


Image Source: http://www.transloc.com
Used with permission

Case Study 2

- Rhythm Engineering's InSync Adaptive Signal Control System
  - For several decades adoption of adaptive signal control systems had been very slow with largely negative experience
  - The InSync System rolled out in 2007
  - A 2009 study of adaptive control systems had to be revised in 2010 because of InSync's rapid growth

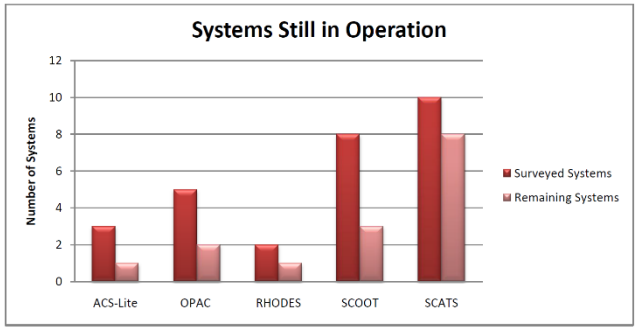


Figure 16: Many of the systems included in the survey have since been abandoned.

Source: Matt Selinger et al., *Adaptive Traffic Control Systems in the United States*, September 2009

System Name	Installations
InSync	92
SCATS	29
ACS-Lite	14
Centracs	14
SCOOT	13

Source: Laboratory for Adaptive Traffic Operations and Management http://latom.eng.fau.edu/

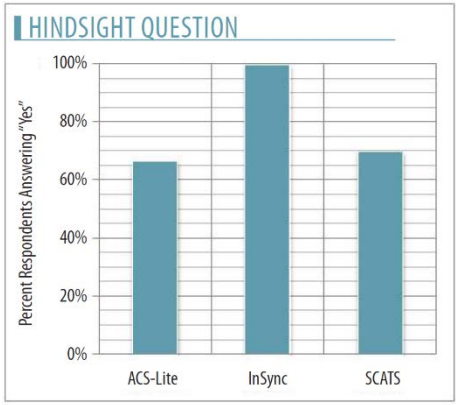


Figure 18: A majority of the respondents would install the same system again if they had the opportunity.

Source: Matt Selinger et al., *Adaptive Traffic Control Systems in the United States: Updated Summary and Comparison*, September 2010

Case Study 3

- SANRAL Design-Build-Operate-Maintain ITS Project
  - Nationwide effort to rapidly deliver a comprehensive, state of the art ITS system for South Africa

THE SOUTH AFRICAN NATIONAL ROADS AGENCY LTD

Creating wealth through infrastructure

  - Innovative contracting mechanism
    - Design, Build, Operate, and Maintain (DBOM)
  - Cary, NC Firm Kimley Horn and Associates is leading the DBOM team as SANRAL's representative

Kimley»Horn

Expect More. Experience Better.

  - Truly a full featured system, including –
    - Video surveillance
    - Electronic tolling
    - Ramp metering
    - Traveler information
    - Etc.

Image Source: Kimley-Horn and Assoc., Inc.
Used with permission

Your ITS Career

- The job opportunities are huge and growing

- Formal curricula and training are evolving

- You will need to take charge of your career preparation

- Long term success will require that you be a lifelong learner

Image Source: ThinkStock/USDOT