Next Generation Weigh-in-Motion (WIM): Enhancing Weighing and Measuring of Military Vehicles/Cargo

Institute for Defense and Government Advancement
3rd Annual Meeting
Lightweight Materials for Defense

Arlington, VA

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Agenda – WIM R&D Activities at ORNL

- Brief Historical Background of WIM at ORNL
- Observations and Actions Resulting from WIM Gen I demonstration at Ft. Bragg/Pope AFB
- WIM Gen II Development Program
- WIM Gen II Testing and Future Plans

Brief History of WIM at ORNL

- ’89-’93 US Department of Energy (DOE) and US Defense Threat Reduction Agency (DTRA)
  - Development of technology for Treaty Verification
- ’95 Air Force PRAM office
  - Built WIM Gen I Prototype
- ‘96 – WIM I Demonstration
  - CASCOM
  - Ft. Bragg
  - Introduction of WIM into Department of Defense Advanced Research Project Agency’s Advanced Logistics Program
- ’98-’00 High Speed Algorithm developed for FHWA and Air Force Mobility Battle Lab
- ’03 – Renewed Interest from Military
  - January US Army Logistics Transformation Agency Government Meeting to address interface between WIM and Automated Airload Planning System (AALPS)
  - 13-14 May WIM Demonstration Ft. Bragg
- ’04 – ORNL Building WIM GEN II
- ’05 – Limited Production, Testing and Determination of Concept of Operations

What is Weigh-in-Motion?

- A portable weigh-in-motion system that enables weighing and recording individual axle weights; measuring and recording spacing between axles; automatically determines vehicle total weight, individual wheel weights, individual axle weights, individual axle spacings, and center of balance.
- Offers the potential to significantly improve the overall Defense Transportation System (DTS) by: reducing manpower required for weighing process; reducing time required for the deployment process; and reducing the potential for human errors.

✓ System developed by Oak Ridge National Laboratory (ORNL)

✓ Two man portable – each component weighs < 150 lbs

✓ Requires minimal assembly

✓ Requires minimal training

✓ Fits in the back of a HMMWV/Pickup Truck

✓ Air transportable on
a 463L pallet or in an ISU 90 or ISU reefer pallet

WIM User Demonstration

- Purpose of User Demo:
  - Determine whether the capabilities of the current Weigh-in-Motion system, with modifications, are sufficient to warrant limited fielding to selected Army TOE and TDA organizations.
  - Provide insights into conceptual, doctrinal & requirements refinements for the objective WIM system
- Demonstration conducted at Fort Bragg/Pope AFB, NC, 12-13 May 03
  - Participants included:
    - LTA (Sponsor)
    - USTRANSCOM (Sponsor Data/Information Interfacing Identification)
    - Oak Ridge National Laboratory (Technical Lead and Facilitator)
    - CASCOM (Requirements Definition)
    - XVIII Airborne Corp (Tactical User) and Fort Bragg/Pope AFB ADACG personnel
    - US ARMY DPMO (EEDSK Fly Away Kit - RF Identification Support)
  - Observers
    - AALPS Support Team
    - U.S. Air Force Air Expeditionary Force Battlelab
    - U.S. Navy Naval Air Terminal Norfolk - Air Mobility Command Terminal

Overall Process Demonstrated - May 03

ORNL Weigh in Motion

Step 1: Automated process using EEDSK captured Unit ID and Vehicle ID with "planned" weights via AIT (RFID, 1D and/or 2D Barcodes) data sent to ITV server.

Step 2: Automated process using WIM captured: Unit ID and Vehicle ID with "actual" weights; Weight (total); Individual Axle; Axle spacing; and Center of Balance.

Step 3: Manual data entry process entered: "Actual" Weight, COB, and ID Info into AALPS

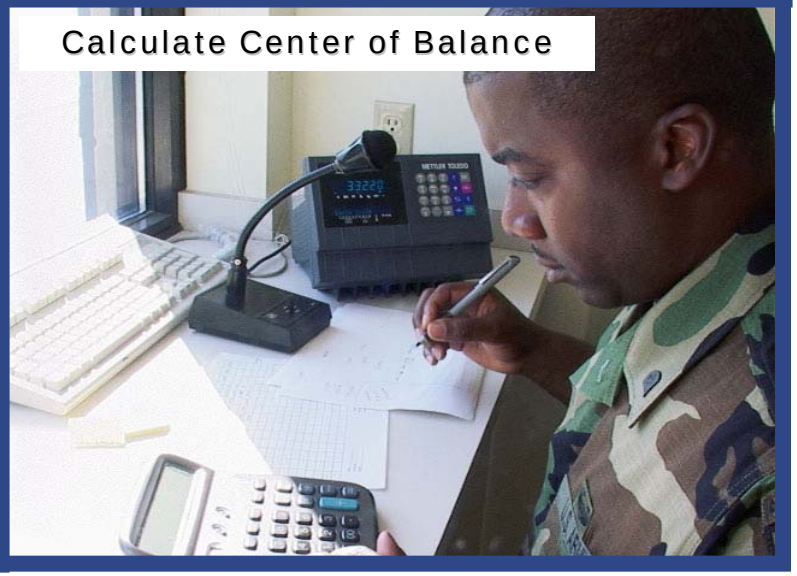
AALPS

Demo process stopped here

TC-AIMS II

In-Ground Scales

ORNL Weigh in Motion

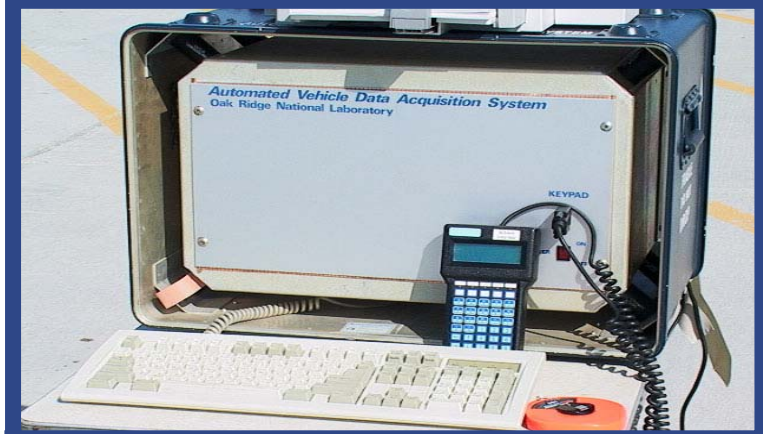


Single Wheel Weight Scale

ORNL Weigh in Motion

Weigh-in-Motion

ORNL Weigh in Motion



5 Ton Truck Crossing WIM

Demonstration at Ft. Bragg May 2003

Sponsored by United States Army Logistics Transformation Agency and United States Transportation Command

Comparison of Portable Weighing Process

ORNL Weigh in Motion

Weigh in Motion (WIM) Versus Single Wheel Weight Scales

WIM Above the line

- Drive vehicle over scale
- WIM calculates weight/center of balance
- WIM transfers data to TC AIMS II/ AALPS
- Turn off engine
- Mark vehicle

0:13 Min

3:03 Min

4:52 Min

7:46 Min

Single Wheel Weight Scales Below the line

- Drive vehicle to scales
- Turn off engine
- Place scales
- Start engine
- Drive vehicle onto scales
- Turn off engine
- Exit driver
- Read each wheel weight
- Calculate axle weights/center of balance
- Enter driver
- Start engine
- Drive vehicle off scales
- Turn off engine
- Remove scales
- Mark vehicle
- Enter data into AALPS

Single Wheel Weight Scales

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Single Wheel Weight Scales

WIM User Demo Technical Results

WIM User Demonstration Technical Results				
Weighing Measuring Techniques	Average Vehicle Time (min:sec) w/marking	Average Vehicle Time (min:sec) w/out marking	Personnel Required	% Vehicle Data with Human Errors
Static Scale/ Tape Measure	7:38	4:48	3	9 %
Individual Wheel Weight Scales/ Tape Measure	7:46	4:52	7	14 %
Weigh-in-Motion System	3:03	0:13	3	0 %

Business Process Modeling Results

- WIM increased the efficiency of the deployment weighing and marking process by reducing:
  - Total scale time by 65%
  - Total number of personnel to support weighing process by 40%
  - Total man-hours by 76%
- Using current process with WIM, bottlenecks occur at other points in the process.
- Use of WIM would be a first step in improving overall process.

Conclusions from WIM User Demonstration

- WIM can:
  - Increase safety of air deployments from austere locations
  - Reduce manpower required to operate scales
  - Increase the speed of the weighing process
  - Reduce the need for re-weighing because of increased accuracy in data calculations and transmissions
  - Increase the safety of the vehicle weighing process.
- WIM has potential to serve as a data collection device to enable automated interfaces that eliminate human computational and recording errors while transmitting data electronically to appropriate logistics and deployment planning systems.
- WIM technologies would be useful for converting fixed scales at Arrival/Departure Airlift Control Groups into TC-AIMS II data collection devices.
- Cubic measurement capability should be integrated into WIM effort. Applicable for sea as well as air deployments.

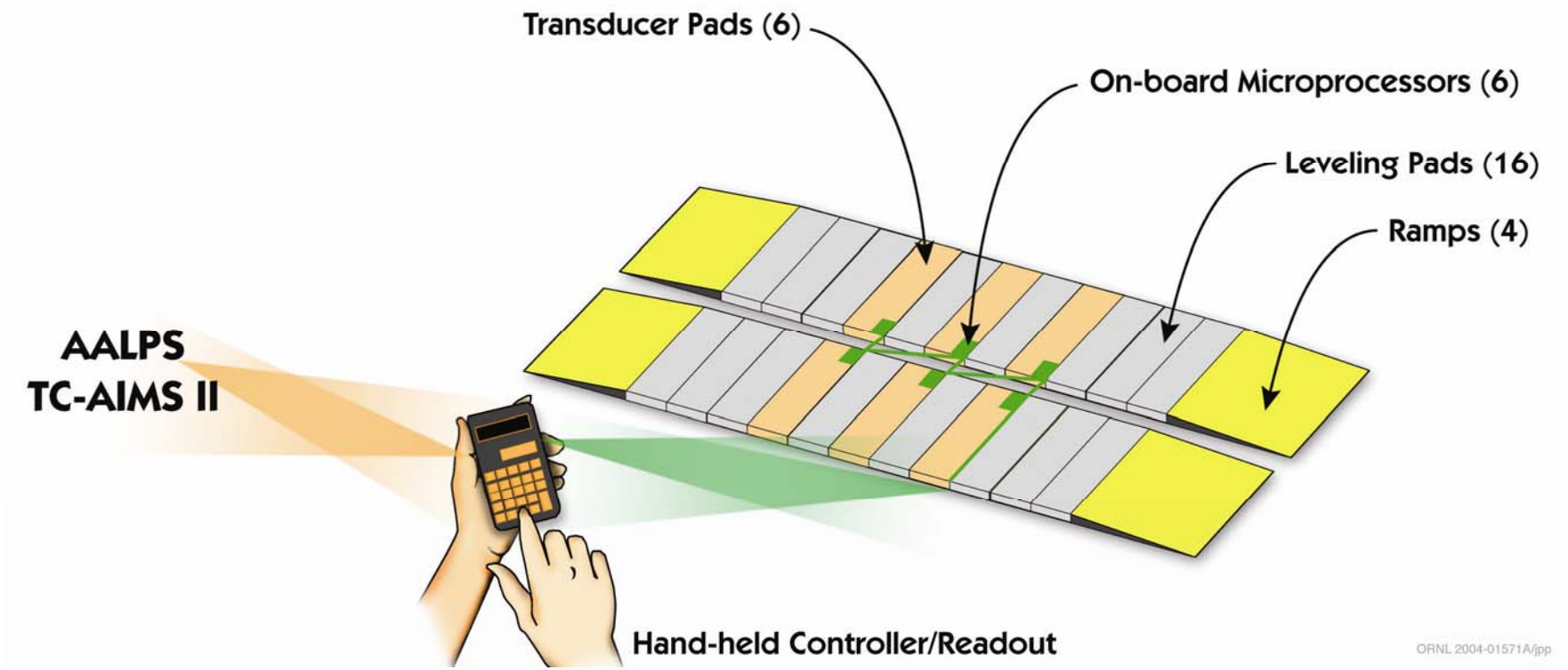
Led to WIM Generation II Development Effort

Weigh-in-Motion

Gen II

Development Program

Portable WIM Gen II Conceptual View



Fully Assembled WIM Gen II

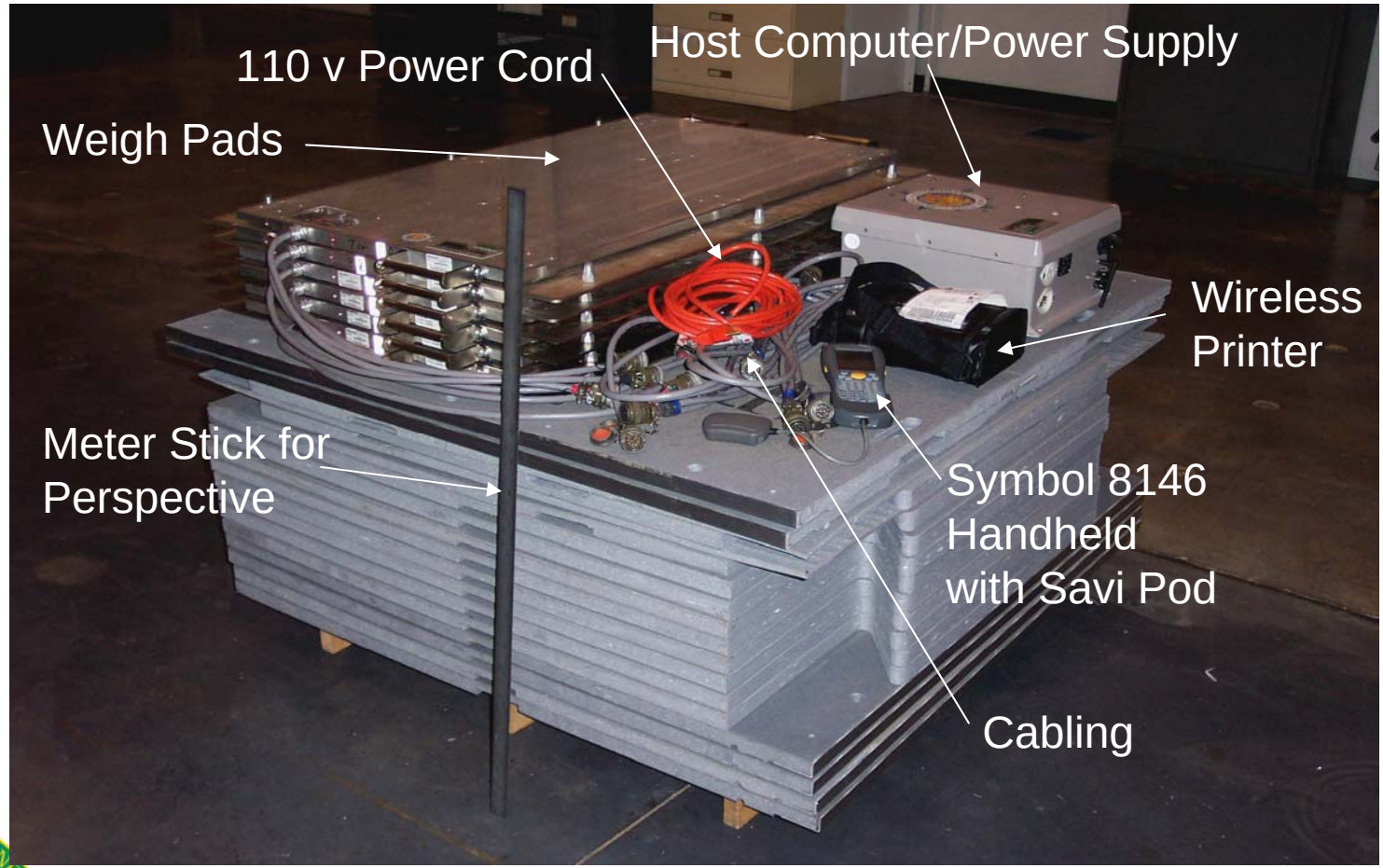
Leveling pads

Power supply/converter

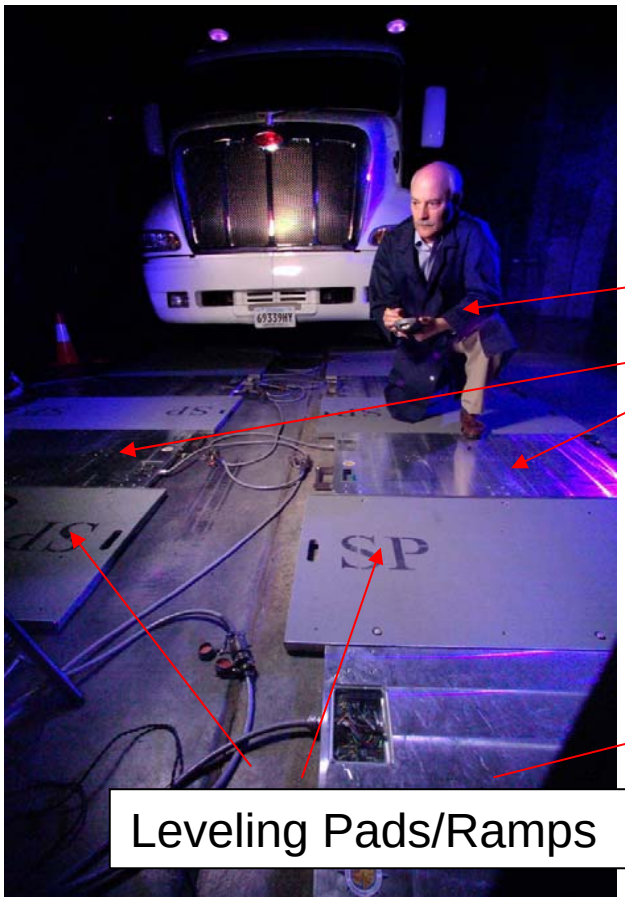
ORNL Cabling

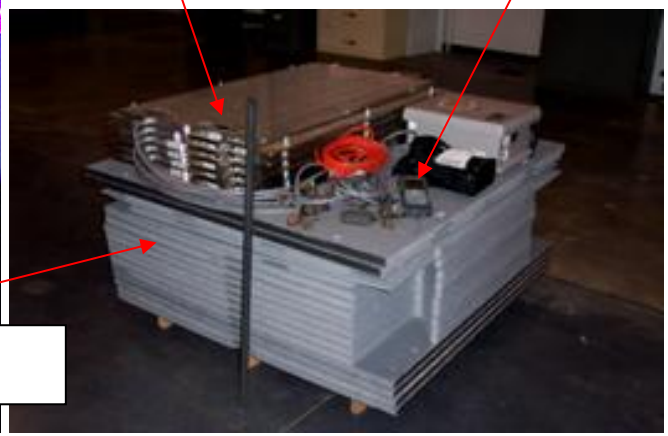
Six individual weigh pads with embedded microcomputer

Disassembled Portable WIM System (4’ X 4’ X 3’)



WIM Gen II Assembled vs. Disassembled





WIM Gen II

Testing and Future Plans

WIM Gen II FY05 Activities

- Coordinate activities with Army G-4, LTA, CASCOM, DPMO, USTRANSCOM, SDDC-TEA and service components
- Procure/Construct WIM Gen II Systems (Limited Production) and Issue to Units to
  - Perform Operational Evaluation/Integration Testing during Exercises, Field Tests, and Deployments
- Upgrade In-ground Fixed Scales to Dual Use (Static or Dynamic) WIM Scales
- Determine Best Configuration for WIM Gen II System through:
  - Statistical Modeling to Determine Best Configuration
- Conduct Integrated Evaluation of WIM with TC-AIMS II, AALPS during Exercises to include Training Support
- Develop Interfaces for Candidate Standard Military Information Systems to Expand Actual Data Versus Planning Data Interfaces
- Determine Best Cubic Technology, Incorporate Cubic Measure into a WIM System, and Prototype Acceptable Technology
- Evaluate Enhancements to Reduce WIM Unit Weight and Optimize Performance

WIM Gen II Future Planned Activities

- Transfer Technical Specs to U.S. Department of Defense
- Department of Defense Plans to:
  - Set up Process to Acquire WIM Production Units and
  - WIM Production and Fielding will be Managed by Appropriate Program Manager
- ORNL will Continue to Provide Technical Assistance and Integration Support

Conclusions

- Technologies presented herein:
  - leverage COTS hardware components and custom developed software that have the provide the following functions:
    - track and locate vehicles and cargo on a worldwide basis,
    - provide the source data for In-transit Visibility and Total Asset Visibility in real-time,
    - extract total vehicle and cargo weight,
    - weigh individual surface contact for each tire,
    - weigh individual axle,
    - locate axle position, and
    - calculate center-of-balance.
- The outputs of the WIM system are provided seamlessly to appropriate logistics planning systems and are subsequently made available to the global transportation network.
- An important and direct tangible benefit of WIM is the result of improved safety and labor savings.