UT-BATTELLE

Oak Ridge National Laboratory
Oak Ridge, Tennessee

WIM Configuration and Data Management Activities

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U. S. DEPARTMENT OF ENERGY

Agenda

- **Time and Motion Study**
  - **Need for WIM**
  - **WIM Gen II…What and Why?**
  - **WIM Gen II – ORNL's Vision**
- **WIM…the DoD Solution**
  - **Conceptual Overview**
  - **System Architecture**
  - **Process Flow**
  - **WIM Gen II Assembled and Disassembled**
- **2005-2006 Accomplishments**
  - **Technical Results**
    - **Representative Data from Three Military Installations**
      - **Ft. Lewis, WA**
      - **Ft. Eustis, VA**
      - **Ft. Bragg, NC**

Time and Motion Study

Technical Results

the Details!

Weigh in Motion (WIM) Versus Single Wheel Weight Scales – Weighing Only

WIM Above the line

Drive vehicle over scale

WIM calculates weight/center of balance

WIM transfers data to TC AIMS II/ AALPS

0:13 Min

Turn off engine

Mark vehicle

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

WIM—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 %***

Averages for representative vehicles, with numbers of axles ranging from 2 to 5. The more the axles, the greater the WIM Advantage.

WIM Gen II

What makes it "Best of Breed for the DoD?"

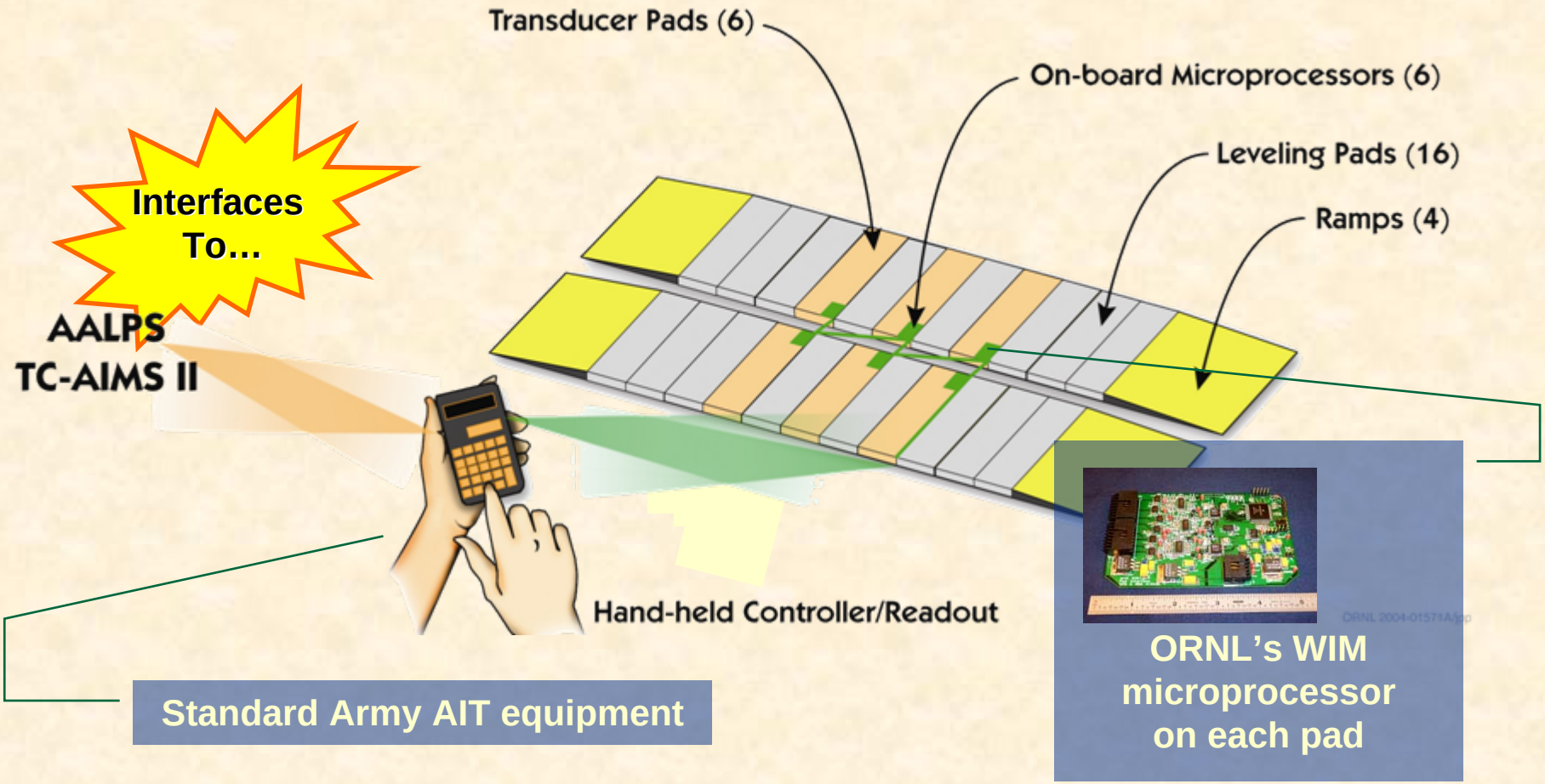
- **Electronically Retrieves Deployment Information**
- **Identifies Vehicle**
- **Automatically Weighs & Determines Center of Balance**
  - **Dynamic or Static**
- **Digital Imaging provides**
  - **Length, Width, Height**
  - **Cube**
- **Provides Marking via**
  - **WIM Placard**
- **"Actual" Data processed to**
  - **Appropriate Deployment Information Systems**

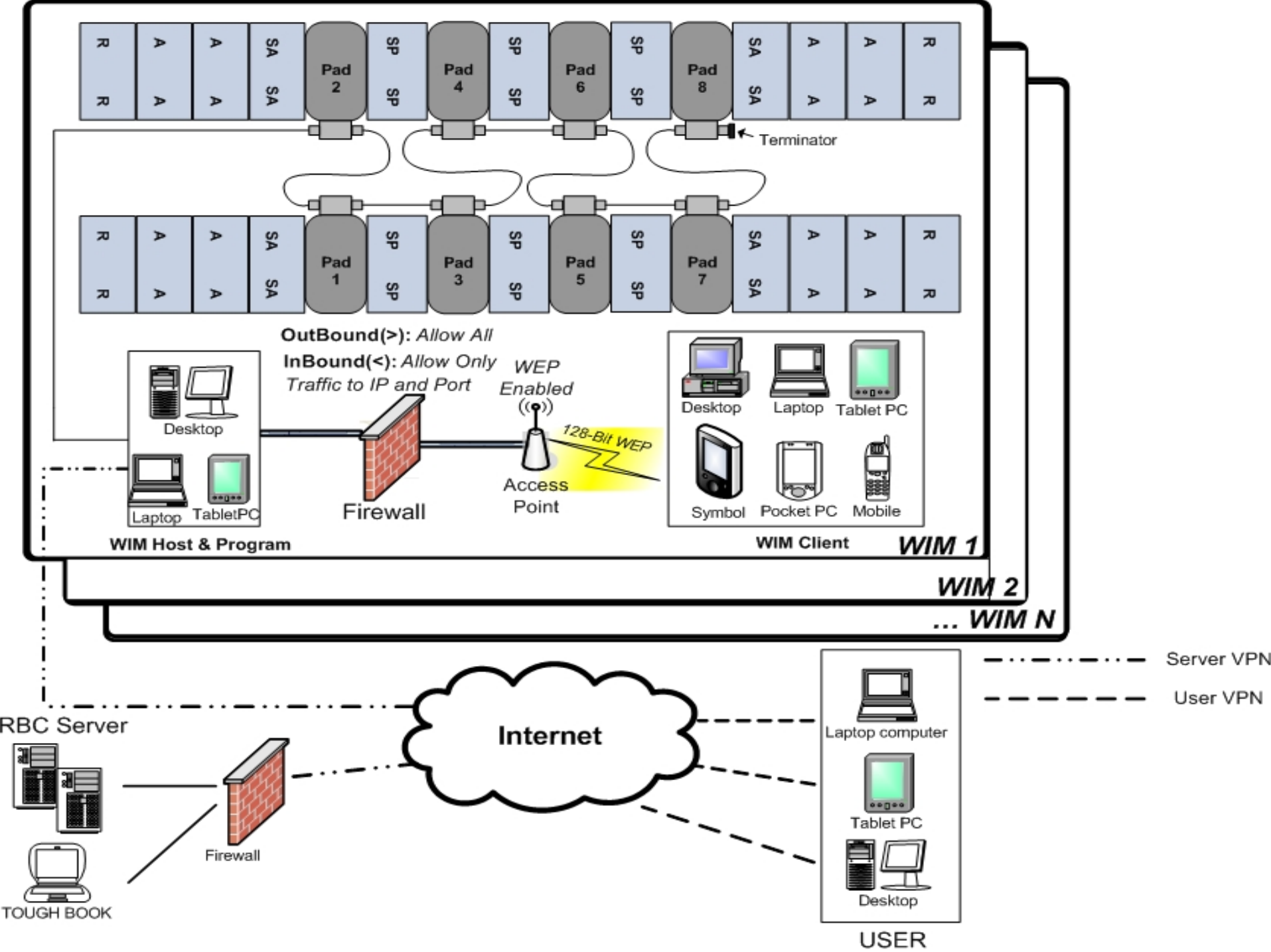
What it is!

Why Weigh-in-Motion (WIM)?

- **Increased Safety**
- **Reduced Manpower**
- **Reduced Time Required for Deployment Process**
- **Eliminates Stress, Weather Related and Other Human Errors**
- **Improved Accuracy:**
  - **Weighs and Records Individual Tire and/or Axle Weights**
  - **Measures and Records Spacing Between Axles**
  - **Calculates Vehicle Center of Balance**
  - **Transfers Collected Data Electronically to Load Planning/In-Transit Visibility (ITV) Systems**

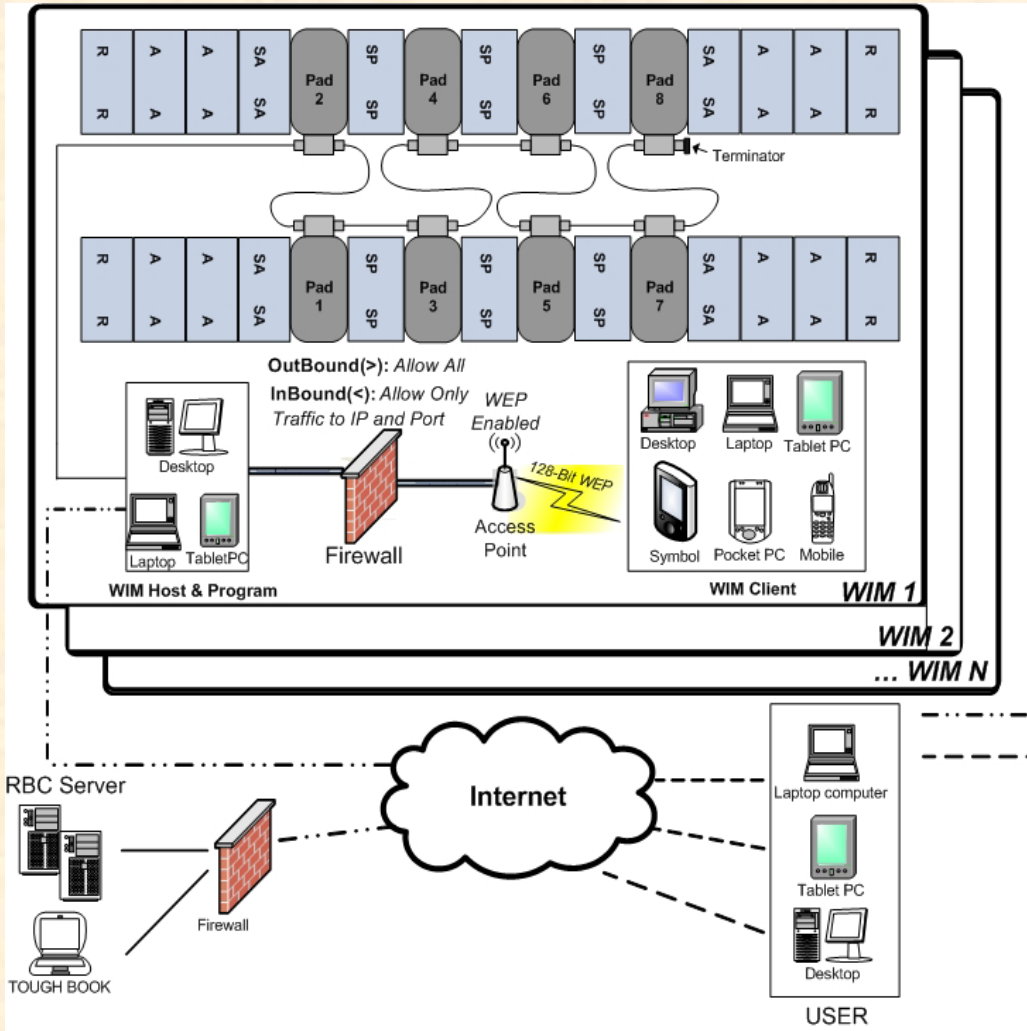
WIM Gen II Conceptual View




R R
A A
A A
SA SA
Pad 2
SP SP
Pad 4
SP SP
Pad 6
SP SP
Pad 8
SA SA
A A
A A
R R
Terminator
Pad 1
Pad 3
Pad 5
Pad 7
OutBound(>): Allow All
InBound(<): Allow Only Traffic to IP and Port
WEP Enabled
128-Bit WEP
Desktop
Laptop
TabletPC
Firewall
Access Point
Desktop
Laptop
Tablet PC
Symbol
Pocket PC
Mobile
WIM Host & Program
WIM Client
WIM 1
WIM 2
... WIM N
Server VPN
User VPN
RBC Server
Internet
Firewall
TOUGH BOOK
Laptop computer
Tablet PC
Desktop
USER

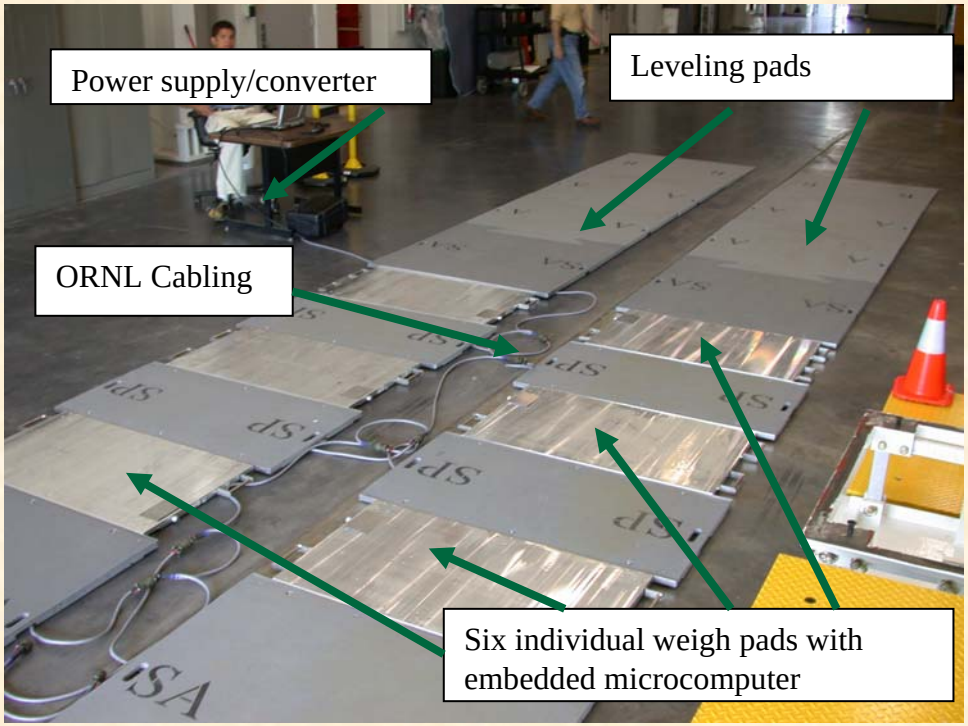
WIM System Architecture and Process Flow

- **The WIM Host collects:**
  - **The weight data from the Pads**
- **The WIM Client is:**
  - **The Operator Controller and System of Record in the Field**
- **Process:**
  - **WIM collects, processes, and stores detailed weight data from the pads to the WIM Host**
  - **The WIM Host communicates the weight data with the WIM Client**
  - **The WIM Client integrates the data with the vehicle records in multiple data formats including TC-AIMS II, AALPS, ICODES, and custom**
  - **The WIM Client securely transmits the vehicle weight and measure data to the Reachback Capability (RBC)**
  - **Authorized users access/retrieve current and/or historical data for analysis**
- **RBC used in field for real-time system integration**



WIM Gen II – Assembled and Disassembled

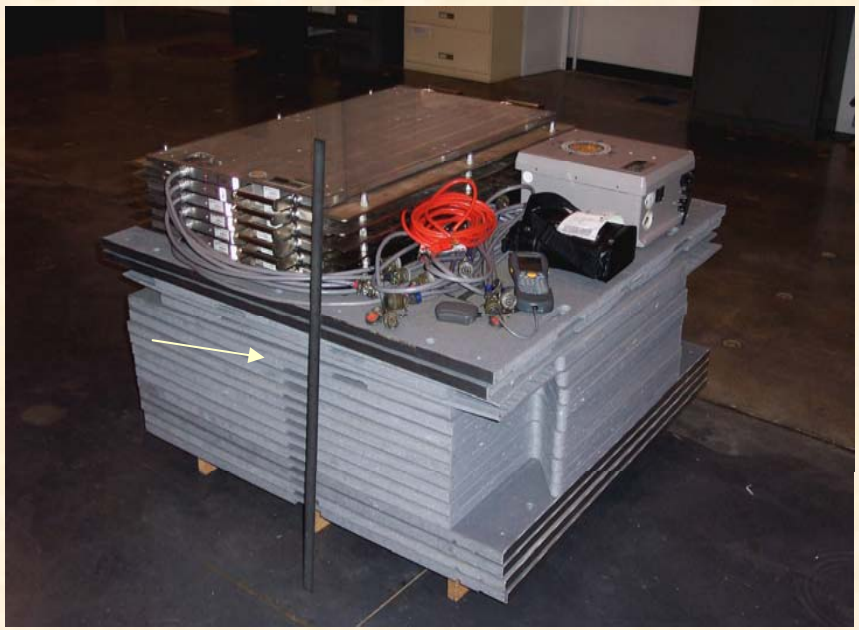
(Currently TRL 6...TRL 7 during FY06)



Fully Assembled WIM Gen II
(40' Long X 10' wide)

(plus 6' wide safety aisles on both sides)

Disassembled Portable WIM Gen II (4' X 4' X 3')



WIM Gen II...Weighing a Stryker

Our Experimental Procedure

- **Goal: Obtain enough information to adequately quantify precision of:**
  - **WIM in Dynamic as well as Stop-and-Go mode**
  - ***In-ground static scales* (IGSS) currently used for the tasks WIM performs**

- **Precision estimates obtained in Dynamic mode (2-, 4-, and 6-pad systems) and Stop-and-Go mode**
  - **Percent error in obtaining Total Vehicle Weight**
  - **Percent error in obtaining Axle Weights**
  - **Percent error in obtaining estimates for Vehicle Center of Balance (1 Standard Deviation) Front Forward Axle (FFA)**
- **Precision estimates obtained from the IGSS**
  - **Percent error in Total Vehicle Weight**
  - **Estimates for axle weights for center of balance were not taken (formerly shown in past testing to be highly unreliable)**

WIM Weighing Procedures

- **Dynamic mode**
  - **Vehicle driven directly over the system, with all wheels hitting their respective left- or right-side pads**
  - **Vehicles must travel at a reasonable speed (typically about 5 mph)**
- **Stop-and-Go mode**
  - **Front wheels (first axle) of the vehicle should be driven slowly onto the first two pads so all of the tire footprint is situated on the pad**
  - **Sufficient time is needed to allow the vehicle to settle after stopping (Software determines when vehicle has sufficiently settled)**
  - **Repeat this procedure for all successive axles**

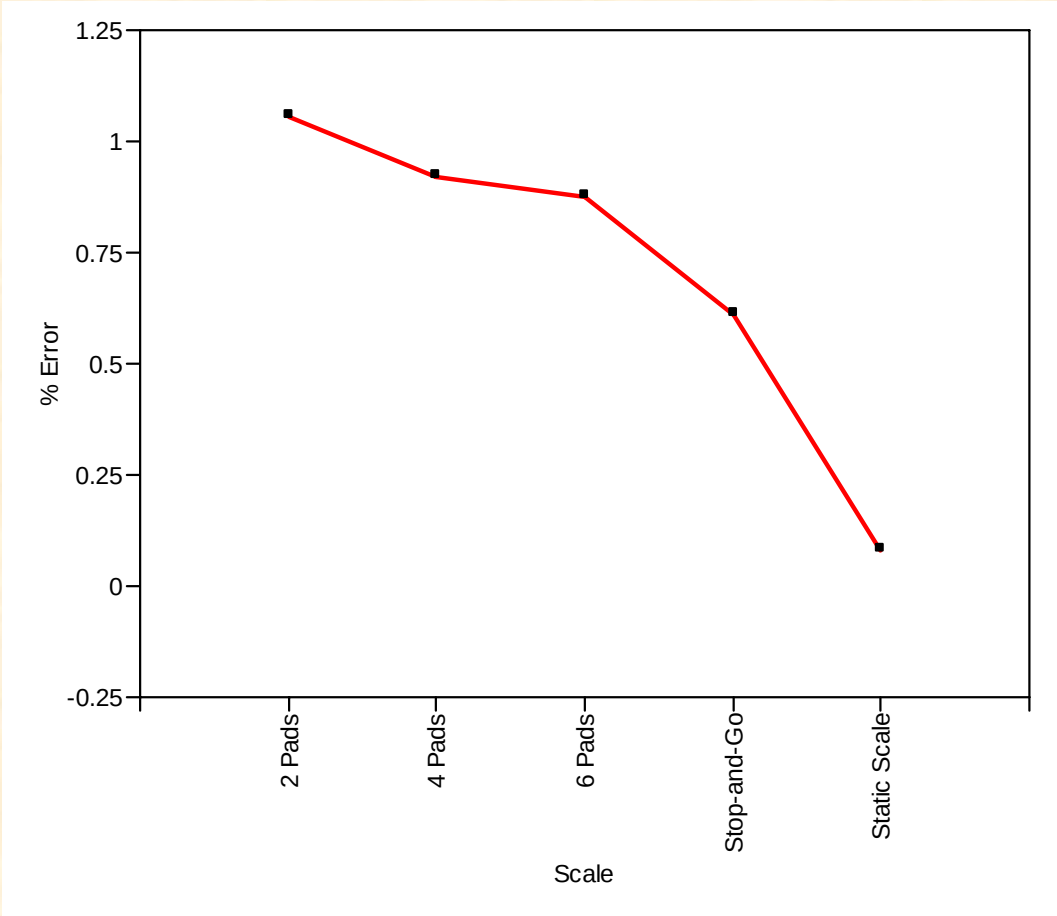
Military vehicles measured at Ft. Lewis

Data obtained from tests run from 9/14/2005-9/15/2005

Vehicle	Number of Axles	Weight (pounds)
CUCV (Commercial Utility Cargo Vehicle)	2	3,255
CUCV Loaded	2	6,468
2.5-Ton LMTV (Light Medium Tactical Vehicle)	2	18,028
5-Ton MTV	3	22,846
5-Ton MTV Loaded	3	29,147
Stryker	4	40,800
PLS (Palletized Load System)	4	51,770

Ft. Lewis – Total Vehicle Weight

Data obtained from tests run from 9/14/2005-9/15/2005



WIM Scale (# of Pads)	% Error
2 Pads	1.06
4 Pads	0.92
6 Pads	0.88
Stop-and-Go	0.61
Static Scale	0.08

Samples taken at Ft. Lewis included 8 vehicles, 8 runs per vehicle (4 in each direction) for WIM data, 2 measurements per vehicle for Stop-and-Go data, and 8 measurements per vehicle on the Static Scale (2 in each direction before WIM, and 2 successive runs after WIM in each direction).

The coefficient of variation (% Error) is a common statistical measure of precision. % Error is calculated as the ratio of one standard deviation of the measurements to the average of the measurements.

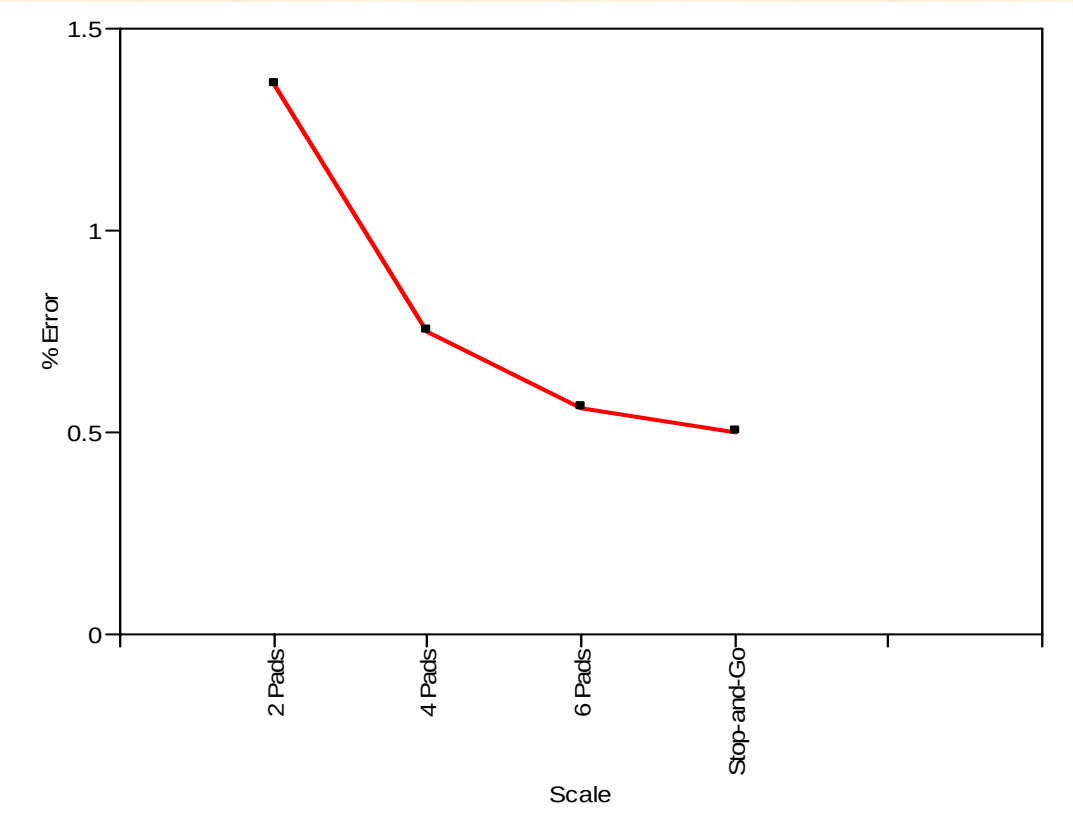
Military vehicles measured at Ft. Eustis

Data obtained from tests run from 1/6/2006

Vehicle	Number of Axles	Weight (pounds)
HMMWV (High Mobility Multipurpose Wheeled Vehicle)	2	3,240
5-Ton MTV	3	26,190
HEMTT (Heavy Expanded Mobility Tactical Truck)	4	43,480

Ft. Eustis – Total Vehicle Weight

Data obtained from tests run from 1/10/2006-1/12/2006



WIM Scale (# of Pads)	% Error
2 Pads	1.36
4 Pads	0.75
6 Pads	0.56
Stop-and-Go	0.50
Static Scale	N/A

Samples taken at Ft. Eustis included 3 vehicles, 10 runs per vehicle for WIM data and 4 measurements per vehicle for Stop-and-Go data.

The coefficient of variation (% Error) is a common statistical measure of precision. % Error is calculated as the ratio of one standard deviation of the measurements to the average of the measurements.

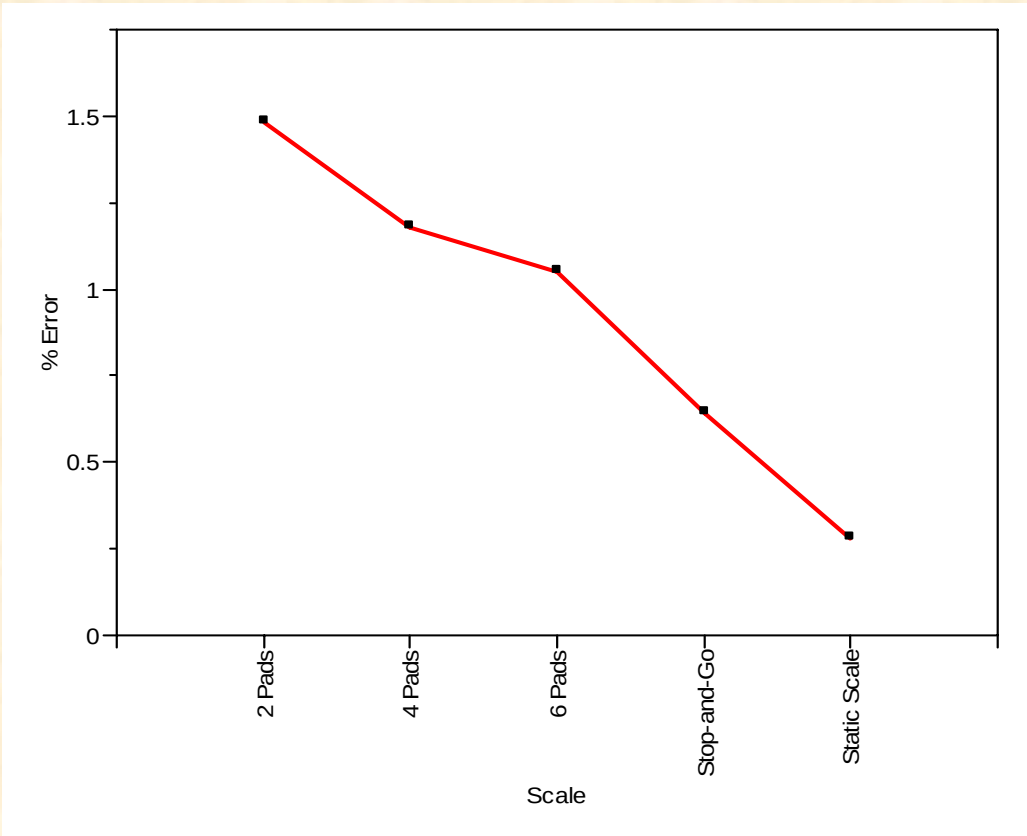
Ft. Bragg – Military Vehicles Measured at Ft. Bragg/Pope AFB

Data obtained from tests run from 1/30/2006-2/1/2006

Vehicle	Number of axles	Weight (pounds)
HMMWV	2	5,677
HMMWV with trailer	3	10,179
2.5-Ton LMTV	2	18,097
2.5-Ton LMTV loaded	2	22,620
HEMTT	4	37,466
HEMTT loaded	4	46,396
PLS	5	51,497

Ft. Bragg – Total Vehicle Weight

Data obtained from tests run from 1/30/2006-2/1/2006



WIM Scale (# of Pads)	% Error
2 Pads	1.48
4 Pads	1.18
6 Pads	1.05
Stop-and-Go	0.64
Static Scale	0.28

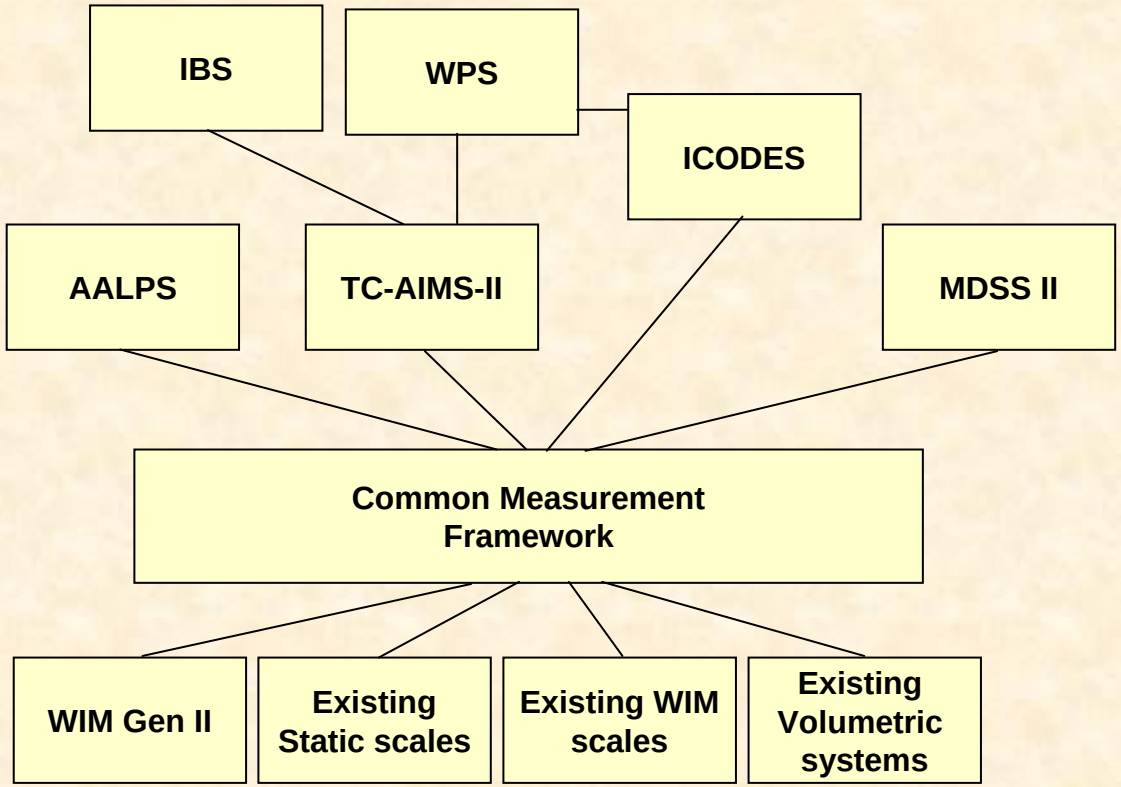
Samples obtained at Ft. Bragg included 5 vehicles, 10 runs per vehicle for the WIM data, 5 measurements per vehicle for Stop-and-Go data, and 4 measurements from the Static Scale (2 before WIM, and 2 after).

The coefficient of variation (% Error) is a common statistical measure of precision. % Error is calculated as the ratio of one standard deviation of the measurements to the average of the measurements.

Common Measurement Framework (CMF)

- **A Software Solution that integrates measurement devices with Defense Transportation System (DTS) Logistics planning systems**
  - **Enables devices to be fielded in any DTS environment and readily interoperate with any on-site Logistics system**
  - **Enables devices to automatically receive and report measurement data to any Logistics system**
  - **Enables devices to become data sources for Logistics planning for:**
    - **Assisting with tracking assets**
    - **Assisting with change and adjustment management**
    - **Assisting with cargo transport assurance**
- **Measurement devices include any new and existing, fielded devices**
  - **including scales, volumetric, static, dynamic**
- **Operates on a standard or ruggedized computers or hand-held devices**
- **Based on the foundation of open systems and interoperability**
  - **Leveraging common data formats and transactions**

CMF Device and Logistic Integration



Weigh-in-Motion

Transforming Deployment Today!