

1. Identify two embedded systems that are sold on the market today and analyze their interfaces.
 1. **Meade TE827W Professional Weather Station** <https://www.meade.com/weather-stations/te827w-professional-weather-station.html>
 1. Monitor screen with several mode/selector buttons.
 2. Internal radio receiver for inputs from several external sensors.
 2. **Nikon COOLPIX B500 Camera** <https://www.nikonusa.com/en/nikon-products/product/compact-digital-cameras/coolpix-b500.html>
 1. Monitor screen
 2. Shutter button
 3. Zoom button
 4. Mode/Selector buttons
2. Describe all inputs to each system and outputs from each system.
 1. **Meade TE827W Professional Weather Station** <https://www.meade.com/weather-stations/te827w-professional-weather-station.html>
 1. **Inputs**
 1. Power AC/DC input
 2. Power Battery input.
 3. Rainfall sensor
 4. Humidity sensor
 5. Temperature sensor
 6. Wind speed sensor
 7. Wind direction sensor
 8. Barometric pressure sensor
 9. Mode selector button up.
 10. Mode selector button down
 11. Set mode button
 12. Channel button
 13. Memory button
 14. History button
 15. Alarm/Chart button
 16. Alarm snooze button
 2. **Outputs**
 1. Display
 1. Weather/Forecast window mode.
 2. Clock/Alarm window mode.
 3. Temperature/Humidity window mode.
 4. Rain window mode.
 5. Wind window mode.
 2. Alarm
 2. **Nikon COOLPIX B500 Camera** <https://www.nikonusa.com/en/nikon-products/product/compact-digital-cameras/coolpix-b500.html>
 1. **Inputs**
 1. CMOS Image sensor

2. 40X Optical Zoom Lens with vibration reduction
3. Electronically controlled aperture
4. Auto-focus sensor
5. Light/Exposure sensor
6. Shutter
7. SD Memory card storage
8. Digital I/O usb

2. Outputs

1. Monitor
2. Digital I/O usb
3. SD Memory card storage
4. WiFi
5. Bluetooth
6. Beeper/Indicator

3. Classify the inputs and outputs based on their mode of interaction.

1. Visual - describing data carried by visible light
2. Audio - describing data carried by sound
3. Tactile - describing data carried by touch
4. Electronic - describing data encoded in electrical signals

5. Meade TE827W Professional Weather

Station <https://www.meade.com/weather-stations/te827w-professional-weather-station.html>

1. Inputs

1. Visual None
2. Audio - None
3. Tactile - None
4. Electronic
 1. Wind speed sensor
 2. Wind direction sensor
 3. Humidity sensor
 4. Barometric pressure sensor
 5. Temperature sensor
 6. Power AC/DC input
 7. Power Battery input.
 8. Mode selector button up.
 9. Mode selector button down
 10. Set mode button
 11. Channel button
 12. Memory button
 13. History button
 14. Alarm/Chart button
 15. Alarm snooze button

2. Outputs

1. Tactile - None
2. Audio
 1. Alarm

3. Electronic

1. Monitor

4. Visual

1. Monitor

1. Pressure/Weather Forecast window mode.

2. Clock/Alarm window mode.

3. Temperature/Humidity window mode.

4. Rain window mode.

5. Wind window mode.

6. **Nikon COOLPIX B500 Camera** <https://www.nikonusa.com/en/nikon-products/product/compact-digital-cameras/coolpix-b500.html>

1. **Inputs**

1. Tactile - None

2. Audio - None

3. Visual

1. CMOS Image sensor

2. 40X Optical Zoom Lens with vibration reduction

3. Auto-focus sensor

4. Light/Exposure sensor

4. Electronic

1. Shutter

2. SD Memory card storage

3. Electronically controlled aperture

4. USB Digital I/O

2. **Outputs**

1. Tactile - None

2. Audio

1. Beeper/Indicator

3. Visual

1. Monitor

4. Electronic

1. Monitor

2. Digital I/O usb

3. SD Memory card storage

4. WiFi

5. Bluetooth

4. For each input and output, estimate the rate at which data is transferred in any units that seem appropriate. For example, a video game with a screen might output video data at 24 frames per second.

1. **Meade TE827W Professional Weather**

Station <https://www.meade.com/weather-stations/te827w-professional-weather-station.html>

1. **Inputs**

1. Power AC/DC input - No data transfer.

2. Power Battery input. - No data transfer

3. Rainfall sensor - RF @ 433 MHz transmitted every 3 minutes.

4. Humidity sensor - RF @ 433 MHz transmitted every 47 seconds.
5. Temperature sensor - RF @ 433 MHz transmitted every 47 seconds.
6. Wind speed sensor - RF @ 433 MHz transmitted every 33 seconds.
7. Wind direction sensor - RF @ 433 MHz transmitted every 33 seconds.
8. Barometric pressure sensor - RF @ 433 MHz transmitted every 20 minutes.
9. Mode selector button up. - No data transfer
10. Mode selector button down - No data transfer
11. Set mode button - No data transfer
12. Channel button - No data transfer
13. Memory button - No data transfer
14. History button - No data transfer
15. Alarm/Chart button - No data transfer
16. Alarm snooze button - No data transfer

2. **Outputs**

1. Display

1. Pressure/Weather Forecast window mode. Updated every 20 minutes.
2. Clock/Alarm window mode. Updated every 1 second.
3. Temperature/Humidity window mode. Updated every 47 seconds.
4. Rain window mode. Updated every 3 minutes.
5. Wind window mode. Updated every 33 seconds.

2. Alarm

2. **Nikon COOLPIX B500 Camera** <https://www.nikonusa.com/en/nikon-products/product/compact-digital-cameras/coolpix-b500.html>

1. **Inputs**

1. CMOS Image sensor. 16 megapixels.
2. 40X Optical Zoom Lens with vibration reduction. Transmits to CMOS sensor at speed of light.
3. Electronically controlled aperture. Allows capture of images at 8 frames per second.
4. Auto-focus sensor. Allows capture of images at 8 frames per second.
5. Light/Exposure sensor. Allows capture of images at 8 frames per second.
6. Shutter. Allows capture of images at 8 frames per second.
7. SD Memory card storage. 25MB/s to 150MB/s depending on speed class of SD card.
8. Digital I/O usb. 60MB/s

2. **Outputs**

1. Monitor. TFT-LCD with 921,000 dots. Estimated maximum refresh at 60 fps.
2. Digital I/O usb. 60MB/s

3. SD Memory card storage 25MB/s to 150MB/s depending on speed class of SD card.
 4. WiFi. 20Mbps
 5. Bluetooth 2Mbps
 6. Beeper/Indicator. Speed of sound.
5. Estimate the “response time” of the system for different inputs. That is, what is the time between when the system receives input and the system responds to that input? For example, a digital camera might take a picture after a button is pressed. The response time would be the time between pressing the button and taking the picture. Explain how you made your estimation.
1. **Meade TE827W Professional Weather Station** <https://www.meade.com/weather-stations/te827w-professional-weather-station.html>
 1. **Selected Inputs. Estimates are taken from specifications in the TE827W user manual.**
 1. Rainfall sensor - 3 minutes.
 2. Humidity sensor - 47 seconds.
 3. Temperature sensor - 47 seconds.
 4. Wind speed sensor - 33 seconds.
 5. Wind direction sensor - 33 seconds.
 6. Barometric pressure sensor - 20 minutes.
 2. **Nikon COOLPIX B500 Camera** <https://www.nikonusa.com/en/nikon-products/product/compact-digital-cameras/coolpix-b500.html>
 1. **Selected Inputs - Estimate based on my own experience using digital point and shoot and digital SLR cameras.**
 1. Electronically controlled aperture. No noticeable lag or latency to human user.
 2. Auto-focus sensor. Always a noticeable delay that is highly dependent on ambient light, motion of the subject, level of zoom, and skill of the user in holding the camera still. In a point and shoot camera the lag can be measured anywhere from microseconds to a couple of seconds.