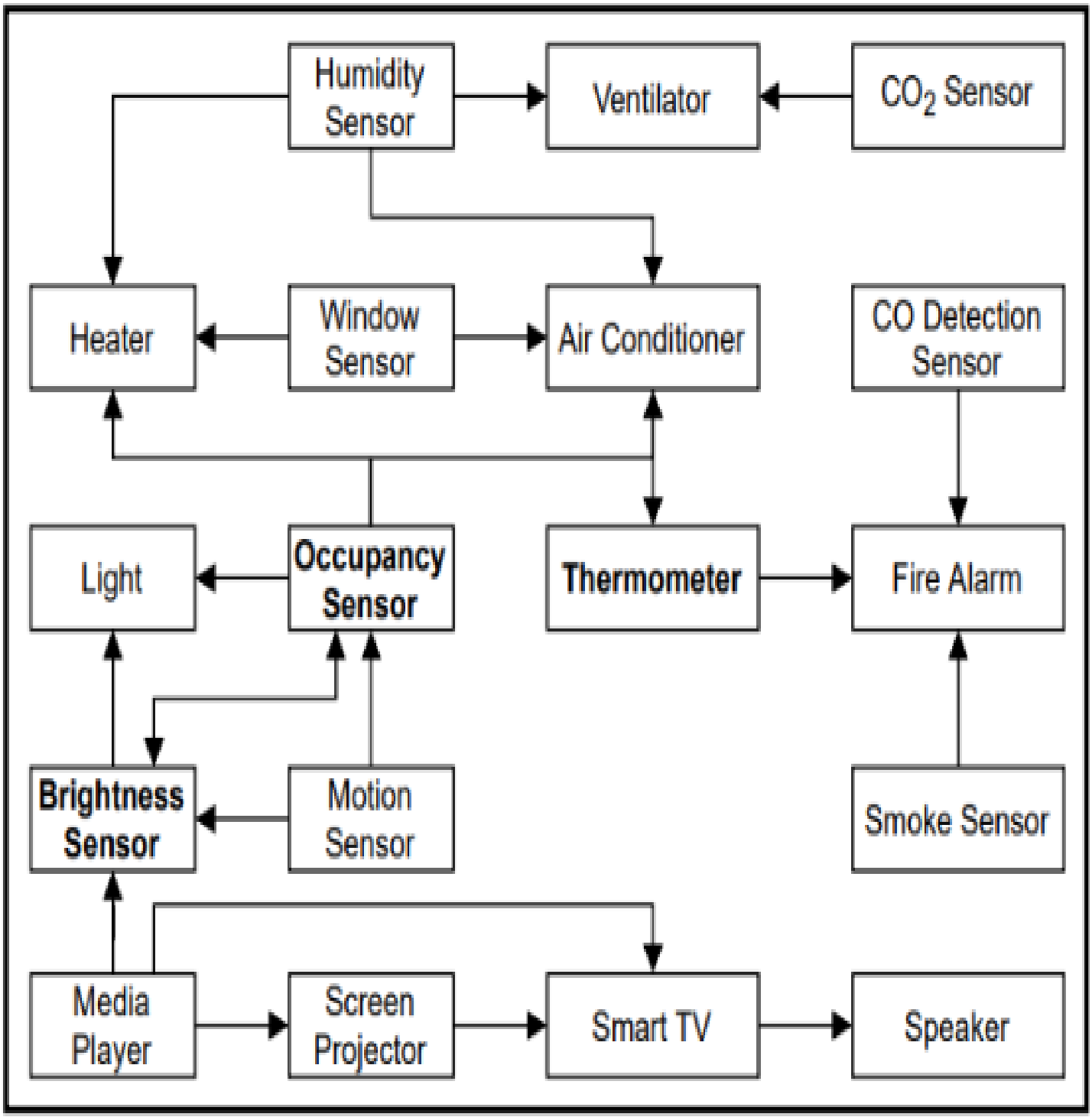
Kalila Lin Cen

Smart Home System

Risk Analysis

This is a security risk assessment on the devices of the smart home system are shown as follow:



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Device	Vulnerability ID	Vulnerability Link
Humidity Sensor	CVE-2022-30339 CVE-2022-46313	https://nvd.nist.gov/vuln/detail/CVE-2022-30339Links to an external site. https://nvd.nist.gov/vuln/detail/CVE-2022-46313Links to an external site.
Ventilator	CVE-2022-42756	https://nvd.nist.gov/vuln/detail/CVE-2022-42756Links to an external site.
CO_2 Sensor	CVE-2022-39106	https://nvd.nist.gov/vuln/detail/CVE-2022-39106Links to an external site.
Heater	CVE-2022-3575 CVE-2022-39128 CVE-2022-39127	https://nvd.nist.gov/vuln/detail/CVE-2022-3575Links to an external site. https://nvd.nist.gov/vuln/detail/CVE-2022-39128Links to an external site. https://nvd.nist.gov/vuln/detail/CVE-2022-39127Links to an external site.
Window Sensor	CVE-2022-39122	https://nvd.nist.gov/vuln/detail/CVE-2022-39122Links to an external site.
Air Conditioner	CVE-2022-39121 CVE-2022-39105	https://nvd.nist.gov/vuln/detail/CVE-2022-39121Links to an external site. https://nvd.nist.gov/vuln/detail/CVE-2022-39105Links to an external site.
CO Detection Sensor	CVE-2022-26474	https://nvd.nist.gov/vuln/detail/CVE-2022-26474Links to an external site.
Light		
Occupancy Sensor	CVE-2022-2841	https://nvd.nist.gov/vuln/detail/CVE-2022-2841Links to an external site.
Thermometer		
Fire Alarm	CVE-2022-39128 CVE-2022-39127	https://nvd.nist.gov/vuln/detail/CVE-2022-39128Links to an external site. https://nvd.nist.gov/vuln/detail/CVE-2022-39127Links to an external site.
Brightness Sensor	CVE-2022-37063	https://nvd.nist.gov/vuln/detail/CVE-2022-37063Links to an external site.
Motion Sensor	CVE-2022-37062	https://nvd.nist.gov/vuln/detail/CVE-2022-37062Links to an external site.
Smoke Sensor	CVE-2022-37061	https://nvd.nist.gov/vuln/detail/CVE-2022-37061Links to an external site.

Media Player	CVE-2022-26474 CVE-2022-39127	https://nvd.nist.gov/vuln/detail/CVE-2022-26474Links to an external site. https://nvd.nist.gov/vuln/detail/CVE-2022-39127Links to an external site.
Screen Projector	CVE-2022-3575 CVE-2022-39128	https://nvd.nist.gov/vuln/detail/CVE-2022-3575Links to an external site. https://nvd.nist.gov/vuln/detail/CVE-2022-39128Links to an external site.
Smart TV	CVE-2022-37063	https://nvd.nist.gov/vuln/detail/CVE-2022-37063Links to an external site.
Speaker	CVE-2022-37062 CVE-2022-39122	https://nvd.nist.gov/vuln/detail/CVE-2022-37062Links to an external site. https://nvd.nist.gov/vuln/detail/CVE-2022-39122Links to an external site.

A) Exploitability score, impact score, and CVSS score for each of the above vulnerabilities.

Device	**Vulnerability ID**	**Exploitability score**	**Impact score**	**CVSS score**
Humidity Sensor	CVE-2022-30339	0.8	3.6	4.4 Medium
	CVE-2022-46313	3.9	1.4	5.3 Medium
Ventilator	CVE-2022-42756	1.8	3.6	5.5 Medium
CO2 Sensor	CVE-2022-39106	1.8	3.6	5.5 Medium
Heater	CVE-2022-3575	3.9	5.9	9.8 Critical
	CVE-2022-39128	1.8	3.6	5.5 Medium
	CVE-2022-39127	1.8	3.6	5.5 Medium
Window Sensor	CVE-2022-39122	1.8	3.6	5.5 Medium
Air Conditioner	CVE-2022-39121	1.8	3.6	5.5 Medium
	CVE-2022-39105	1.8	3.6	5.5 Medium
CO Detection Sensor	CVE-2022-26474	0.8	5.9	6.7 Medium
Occupancy Sensor	CVE-2022-2841	1.2	1.4	2.7 Low
Fire Alarm	CVE-2022-39128	1.8	3.6	5.5 Medium
	CVE-2022-39127	1.8	3.6	5.5 Medium
Brightness Sensor	CVE-2022-37063	2.3	2.7	5.4 Medium
Motion Sensor	CVE-2022-37062	3.9	3.6	7.5 High
Smoke Sensor	CVE-2022-37061	3.9	5.9	9.8 Critical
Media Player	CVE-2022-26474	0.8	5.9	6.7 Medium
	CVE-2022-39127	1.8	3.6	5.5 Medium
Screen Projector	CVE-2022-3575	3.9	5.9	9.8 Critical
	CVE-2022-39128	1.8	3.6	5.5 Medium
Smart TV	CVE-2022-37063	2.3	2.7	5.4 Medium
Speaker	CVE-2022-37062	3.9	3.6	7.5 High
	CVE-2022-39122	1.8	3.6	5.5 Medium

B) Vulnerability Level Calculation

Device	Vulnerability ID	Attack success probability	Attack impact	Attack risk	CVSS base score	Vector
Humidity Sensor	CVE-2022-30339	0.08	3.6	0.288	4.4	CVSS:3.1/AV:L/AC:L/PR:H/UI:N/S:U/C:N/I:N/A:H
	CVE-2022-46313	0.39	1.4	0.546	5.3	CVSS:3.1/AV:N/AC:L/PR:N/UI:N/S:U/C:N/I:N/A:L
Ventilator	CVE-2022-42756	0.18	3.6	0.648	5.5	CVSS:3.1/AV:L/AC:L/PR:L/UI:N/S:U/C:N/I:N/A:H
CO2 Sensor	CVE-2022-39106	0.18	3.6	0.648	5.5	CVSS:3.1/AV:L/AC:L/PR:L/UI:N/S:U/C:N/I:N/A:H
Heater	CVE-2022-3575	0.39	5.9	2.301	9.8	CVSS:3.1/AV:N/AC:L/PR:N/UI:N/S:U/C:H/I:H/A:H
	CVE-2022-39128	0.18	3.6	0.648	5.5	CVSS:3.1/AV:L/AC:L/PR:L/UI:N/S:U/C:N/I:N/A:H
	CVE-2022-39127	0.18	3.6	0.648	5.5	CVSS:3.1/AV:L/AC:L/PR:L/UI:N/S:U/C:N/I:N/A:H
Window Sensor	CVE-2022-39122	0.18	3.6	0.648	5.5	CVSS:3.1/AV:L/AC:L/PR:L/UI:N/S:U/C:N/I:N/A:H
Air Conditioner	CVE-2022-39121	0.18	3.6	0.648	5.5	CVSS:3.1/AV:L/AC:L/PR:L/UI:N/S:U/C:N/I:N/A:H
	CVE-2022-39105	0.18	3.6	0.648	5.5	CVSS:3.1/AV:L/AC:L/PR:L/UI:N/S:U/C:N/I:N/A:H
CO Detection Sensor	CVE-2022-26474	0.08	5.9	0.472	6.7	CVSS:3.1/AV:L/AC:L/PR:H/UI:N/S:U/C:H/I:H/A:H
Occupancy Sensor	CVE-2022-2841	0.12	1.4	0.168	2.7	CVSS:3.1/AV:N/AC:L/PR:H/UI:N/S:U/C:N/I:L/A:N
Fire Alarm	CVE-2022-39128	0.18	3.6	0.648	5.5	CVSS:3.1/AV:L/AC:L/PR:L/UI:N/S:U/C:N/I:N/A:H
	CVE-2022-39127	0.18	3.6	0.648	5.5	CVSS:3.1/AV:L/AC:L/PR:L/UI:N/S:U/C:N/I:N/A:H
Brightness Sensor	CVE-2022-37063	0.23	2.7	0.621	5.4	CVSS:3.1/AV:N/AC:L/PR:L/UI:R/S:C/C:L/I:L/A:N
Motion Sensor	CVE-2022-37062	0.39	3.6	1.404	7.5	CVSS:3.1/AV:N/AC:L/PR:N/UI:N/S:U/C:H/I:N/A:N
Smoke Sensor	CVE-2022-37061	0.39	5.9	2.301	9.8	CVSS:3.1/AV:N/AC:L/PR:N/UI:N/S:U/C:H/I:H/A:H
Media Player	CVE-2022-26474	0.08	5.9	0.472	6.7	CVSS:3.1/AV:L/AC:L/PR:H/UI:N/S:U/C:H/I:H/A:H
	CVE-2022-39127	0.18	3.6	0.648	5.5	CVSS:3.1/AV:L/AC:L/PR:L/UI:N/S:U/C:N/I:N/A:H
Screen Projector	CVE-2022-3575	0.39	5.9	2.301	9.8	CVSS:3.1/AV:N/AC:L/PR:N/UI:N/S:U/C:H/I:H/A:H
	CVE-2022-39128	0.18	3.6	0.648	5.5	CVSS:3.1/AV:L/AC:L/PR:L/UI:N/S:U/C:N/I:N/A:H
Smart TV	CVE-2022-37063	0.23	2.7	0.621	5.4	CVSS:3.1/AV:N/AC:L/PR:L/UI:R/S:C/C:L/I:L/A:N
Speaker	CVE-2022-37062	0.39	3.6	1.404	7.5	CVSS:3.1/AV:N/AC:L/PR:N/UI:N/S:U/C:H/I:N/A:N
	CVE-2022-39122	0.18	3.6	0.648	5.5	CVSS:3.1/AV:L/AC:L/PR:L/UI:N/S:U/C:N/I:N/A:H

*Attack Success Probability = Exploitability Score / 10

*At the vulnerability level, the attack impact value is extracted from the NVD database.

*Attack Risk = Attack success probability * Attack impact

*The corresponding values (e.g., access vector, access complexity) to calculate the CVSS base score are taken from the NVD database for a vulnerability.

Example: Humidity Sensor with CVE-2022-30339.

- Attack success probability = 0.8/10 = 0.08
- Attack impact = 3.6 based on NVD database.
- Attack risk = 0.08 * 3.6 = 0.288
- Based on the Access vector [CVSS:3.1/AV:L/AC:L/PR:H/UI:N/S:U/C:N/I:N/A:H] sourced from the NVD database, the qualitative severity ratings for Confidentiality, Integrity, and Availability are 'None', 'Low', and 'High', respectively. As the exact numerical representations for these ratings aren't provided, I've opted to use the original CVSS base score from the NVD. This approach differs from the formula in the document 'Risk- Analysis/Risk Calculation.pdf' found at 'main · FaheemCrest/Risk-Analysis' on GitHub, which was provided by our lecturer.

C) Node level: Security risk, attack probability, attack impact, and CVSS Base score associated with each device.

Device	**Vulnerability ID**	**Security risk**	**Attack probability**	**Attack impact**	**CVSS base score**
Humidity Sensor	CVE-2022-30339 CVE-2022-46313	1.5132, 8.372504	0.0312, 0.4388	5, 3.6	9.7, 5.3
Ventilator	CVE-2022-42756	3.564	0.18	3.6	5.5
CO2 Sensor	CVE-2022-39106	3.564	0.18	3.6	5.5
Heater	CVE-2022-3575 CVE-2022-39128 CVE-2022-39127	3.4224192, 34.2078212	0.012564, 0.591316	13.1, 5.9	20.8, 9.8
Window Sensor	CVE-2022-39122	3.564	0.18	3.6	5.5
Air Conditioner	CVE-2022-39121 CVE-2022-39105	2.56608, 6.48648	0.0324, 0.3276	7.2, 3.6	11, 5.5
CO Detection Sensor	CVE-2022-26474	1.584	0.08	5.9	6.7
Occupancy Sensor	CVE-2022-2841	0.4536	0.12	1.4	2.7
Fire Alarm	CVE-2022-39128 CVE-2022-39127	2.56608, 6.48648	0.0324, 0.3276	7.2, 3.6	11, 5.5
Brightness Sensor	CVE-2022-37063	3.3534	0.23	2.7	5.4
Motion Sensor	CVE-2022-37062	10.53	0.39	3.6	7.5
Smoke Sensor	CVE-2022-37061	22.5498	0.39	5.9	9.8
Media Player	CVE-2022-26474 CVE-2022-39127	1.66976, 9.706088	0.0144, 0.2456	9.5, 5.9	12.2, 6.7
Screen Projector	CVE-2022-3575 CVE-2022-39128	10.21887, 28.918836	0.0702, 0.4998	9.5, 5.9	15.3, 9.8
Smart TV	CVE-2022-37063	3.3534	0.23	2.7	5.4

Speaker	CVE-2022-37062 CVE-2022-39122	6.57072, 13.4946	0.0702, 0.4998	7.2, 3.6	13, 7.5

*Security risk calculation is not provided; therefore I will use the common approach: Security risk = Attack success probability × Attack impact × CVSS base score

Example: Humidity Sensor with CVE-2022-30339, CVE-2022-46313.

- Attack Success Probability

ASP (AND gate) = 0.08* 0.39 = 0.0312

ASP (OR gate) = 1 – (1 - 0.08) *(1 - 0.39) = 0.4388

- Attack Impact

AI (AND gate) = 3.6 + 1.4 = 5

AI (OR gate) = max AI = 3.6

CVSS Base Score

CVSS (AND gate) = 4.4 + 5.3 = 9.7 CVSS (OR gate) = max CVSS = 5.3

- Security risk

0.0312*5*9.7 = 1.5132

0.4388*3.6*5.3 = 8.372504

D) Path level: Security risk, attack probability, attack impact, and CVSS Base score per path.

Attack path	**Security risk**	**Attack success probability**	**Attack impact**	**CVSS base score**
Path 1: Humidity sensor ---> Air Conditioner ---> Thermometer ---> Fire Alarm	9.96530288182, 158887.347	0.000033093888, 0.046960903168	259.2, 46.65646.656	1169.7, 160.115
Path 2: *Media Player ---> Brightness Sensor ---> Occupancy Sensor ---> Heater*	64.818516, 5004.307435	0.0000413534464, 0.0415777600512	429.381, 132.4526	3649.5616, 899.1964

Example: Path 1

Attack success probability

- Humidity sensor = 0.0312, 0.4388
- Air Conditioner = 0.0324, 0.3276
- Thermometer = NA
- Fire Alarm = 0.0324, 0.3276
- 0.0312*0.0324*0.0324= 0.000033093888
- 0.4388*0.3276*0.3276= 0.046960903168

Attack impact

- Humidity sensor = 5, 3.6
- Air Conditioner = 7.2, 3.6
- Thermometer = NA
- Fire Alarm = 7.2, 3.6
- 5*7.2*7.2 = 259.2
- 3.6*3.6*3.6 = 46.65646.656

CVSS base score

- Humidity sensor = 9.7, 5.3
- Air Conditioner = 11, 5.5
- Thermometer = NA
- Fire Alarm = 11, 5.5
- 9.7*11*11 = 1169.7
- 5.3*5.5*5.5 = 160.115

Security risk

- 0.000033093888*259.2*1169.7 = 9.96530288182
- 0.046960903168*46.65646.656*160.115 = 158887.347

E) Security risk, attack success probability, attack impact, and CVSS base score for the entire smart home system.

System	Security risk	Attack success probability	Attack impact	CVSS base score
Entire smart home system	158887.347	0.046960903168	429.381	3649.5616